Pesticides Abstracts and News Summary

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SECTION A

INSECTICIDES

Vol. 7 No. 1 February 1961

COLONIAL PESTICIDES RESEARCH COMMITTEE
COLONIAL OFFICE, LONDON

The abstracts contained in P.A.N.S. are in general abstracts of interim reports. The conclusions stated are, therefore, tentative and may be modified by the results of subsequent investigations.

Permission to quote from these abstracts or the original papers must be obtained from the authors.

Enquiries should be addressed to: Colonial Pesticides Information Service, Tropical Products Institute, 56/62, Gray's Inn Road, London, W.C.1.

NOTICE

SECTION B - FUNGICIDES

For some time we have wanted to make the "PANS" service more complete by issuing a Section B on Fungicides. A certain number of items on fungicides have up to now been incorporated in Section A, but beginning with Vol. 7, No. 2, it is hoped to expand this material to form a Section B (Fungicides), which will be bound up with Section C and covered by the same subscription.

The series will then be:-

	Section A	Insecticides
Bound together	(Section C	Herbicides, Arboricides, Defoliants
	(Section B	Fungicides

NEWS ITEMS - GENERAL

FREEDOM FROM HUNGER CAMPAIGN

On July 1st, 1960 the Freedom from Hunger Campaign was formally launched at FAO's Rome Headquarters and in the participating countries throughout the world. Messages supporting the Campaign were received from President Eisenhower, General de Gaulle, Pope John XXIII, Mr. Macmillan, President Tito, Queen Juliana, and many other heads of governments and states.

At the conclusion of his statement on the Campaign, B.R. Sen, FAO's Director-General, said "It has become a common saying of our time that peace is indivisible. I would go deeper than that. I would say that peace can become truly indivisible only after we have recognised and acted upon the fundamental truth that man himself is indivisible. One man's hunger and want is every man's hunger and want. One man's freedom from hunger and want is neither a true nor a secure freedom until all men are free from hunger and want.

In the middle of the twentieth century, in the hour of man's mastery over matter and space, I would say to you that for disaster or triumph - man, hunger, plenty, peace, the earth and the fruits thereof, all are indivisible. In this belief and with faith in human destiny, I have the honour on behalf of the Member Nations of this Organisation, to launch the Freedom from Hunger Campaign."

Note

Production of cereal grains in 1956, excluding the USSR, was 756,000,000 metric tons, of which at least 10% was destroyed by insects, rodents and fungi, a loss of 75,600,000 tons. At an average ration of 800 grammes daily per person, this would have fed 255,000,000 people for a year.

(F.A.O. Bulletin No. 10/1960).

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE IN GREAT BRITAIN

Recommendations, for safe use in agriculture and horticulture of the compounds noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Fluoroacetamide	Issued: February 1960
Arylmercury fungicidal sprays	Issued: August 1960
Endrin on blackcurrants	Revised: August 1960
Gusathion	Revised: December 1960
Ethion	Issued: January 1961
Thiodan	Issued: January 1961

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

FOREST PEST CONTROL

Rotary Atomiser Tests: The general policy of testing machinery which appears to be useful for forest insect control operations gave rise during the year to a trial of rotary atomisers fitted to aircraft. These atomisers produce spray droplets by feeding the spray liquid into a rotating cylinder of wire mesh, from the periphery of which the droplets are thrown off by centrifugal force. This device is an alternative to, and is claimed to be an improvement on, the normal boom and jet rig fitted to most spraying aircraft, since the droplet size can be closely regulated to allow of small droplets being obtained and since, further, the variability in size of the droplets is small. These two factors permit good coverage to be obtained with low rates of application, and this, of course, has considerable economic advantage.

The trial was sited at Tentsmuir Forest in two compartments of P.24 and P.25 Scots pine and Corsican pine, which harboured countable but not very high numbers of pine looper larvae and of larvae of the sawfly, *Acantholyda posticalis* Mats. These compartments were sprayed with a 10% DDT preparation, one compartment receiving one gallon of spray per acre and the other one half-gallon of spray per acre. Trays had been set out on the forest floor and the dead and moribund larvae falling on to them after spraying were counted. These assessments were continued until no more larvae were found on the trays, after which the sections of canopy immediately above the trays were heavily overdosed with a DDT fog emitted from a Swingfog machine. Then further counts of larvae falling to the trays were made. In this way it was possible to compare the numbers of larvae killed by aerial sprayings with the presumed total number of larvae present i.e. those killed by spraying plus those killed by the heavy fog application. The results indicated that approximately 80% of the population was killed by spraying at the rate of one half-gallon per acre, and that the mortality in the compartment sprayed at the rate of one gallon per acre was approximately 99%. As a first trial these results are promising, and further tests with rotary atomisers are being planned.

(Report on Forest Research for the Year Ended March, 1959. Forestry Commission)

JOINT ACTION CAMPAIGN AGAINST TSETSE FLY IN SOUTH EASTERN AFRICA. Lourenco Marques, Nov. 7th, 8th, 1960.

The 6th Meeting of I.S.C.T.R. held at Jos in July, 1960 had recommended that C.C.T.A. should call upon the Member Governments of the Federation of Rhodesia and Nyasaland, Portugal and the Union of South Africa to consider the desirability of appointing a Joint Working Party, whose object would be to prepare an agreed plan of campaign together with an assessment of requirements in terms of personnel and finance to stem the continuous spread of the tsetse fly from Southern Rhodesia and Mozambique, Southwards towards the Union.

After consulting the Governments concerned, the C.C.T.A. Secretariat proposed that this recommendation should be implemented as early as possible and suggested that a meeting of the Working Party be held in Lourenco Marques on November 7th and 8th, 1960.

The Governments concerned agreed and subsequent arrangements were made by the Interafrican Bureau for Animal Health of C.C.T.A.

Conclusions

The Working Party having reviewed the problem on the basis of fresh statements made to it by the delegates of the countries concerned, wishes to *reiterate*, that a potentially serious situation exists in South-Eastern Africa, caused by the steady advance in a southern direction, of the tsetse fly from Southern Rhodesia and Mozambique toward the Union of South Africa and while, *conscious* of the efforts to halt this advance, now in progress in Southern Rhodesia and Mozambique, *considers* that the problem calls for urgent additional action with external resources directed in the first place towards holding the tsetse fly on its present front and thence attacking in other directions to be decided later and, is of the *opinion*, that such action should be carried out in one project on an international basis over the whole area involved.

Recommendations

(1) That an ecological survey be carried out.

(2) That an aerial photographic survey of the whole front involved be carried out in the dry season.

(3) That arrangements be made for a South African team to carry out a pupal casing survey, to establish the breeding sites of the tsetse.

(4) That an aerial spraying pilot project be carried out in a *Glossina morsitans* area, where conditions are comparable to those of the *G. pallidipes* area.

(5) That the frontage of operations should be regarded as approximately 400 miles in length and that a staff of one entomologist, 4 field officers and supporting African labour, would be required per 100 miles of linear frontage.

(6) That capital and recurrent expenditure over a period of ten years will be required. (Total expenditure is estimated at about £2 m.)

(7) That the governments concerned should ensure by all possible means that the departments involved in the problem under review, be brought-up to full establishment and maintained thereat, if only to preserve the "status quo" in the tsetse-fly situation.

(8) That an Interterritorial Standing Committee be established.

(9) That the countries concerned should assemble relevant information, as will be indicated, to permit a Working Party for this area to be convened as early as possible in 1961.

NEW INDUSTRIAL BIOLOGICAL RESEARCH ASSOCIATION FORMED

Food and Allied Industries in Joint Project: A new research organisation - the British Industrial Biological Research Association - has been formed to study the possible effects upon health and to ensure the harmlessness of substances which may be ingested in food, drinks and cosmetics. Supported by a number of leading companies in the food, chemical, essences, plastics, packaging and cosmetic industries, together with certain important distributive concerns, it is welcomed by interested Government Departments and will receive a grant from the Department of Scientific and Industrial Research. It becomes the 52nd Research Association to join the Government Scheme.

The Association's main object is the establishment of a biological research station for investigating the effect of the many substances used in food manufacture, either as processing aids or for flavouring and colouring food, as well as those which may get into food from pesticides, from plant used in food manufacture, from packaging materials, or from utensils. Although some of the larger companies in the food and chemical industries have their own research facilities, until now there has been no national industrial organisation in this country with responsibility for work of this kind.

There is a lack of data on the effect of these substances on health, particularly when they are ingested in small quantities over a long period of time. Further development of test methods using experimental animals is also needed. Results of related research in other establishments throughout the world will be studied and interpreted for members as part of an advisory and information service.

Firm undertakings of support, for a total sum of approximately £23,000 a year for the first five years, have already been given by 90 individual companies. In addition D.S.I.R. has agreed to match the industrial subscription £1 for £1 up to a total grant of £47,000 a year. While this is in excess of the income at present guaranteed by industry it reflects the Research Association's own confident expectations of further industrial support. The Association hopes to build its laboratories at Leatherhead, Surrey, on land leased from the British Food Manufacturing Industries Research Association, which has offered to share some facilities and administrative services in the initial stages. Subject to the satisfactory conclusion of negotiations, most of the buildings should be completed by the end of 1961 and the research station should be fully operative by mid-1962. The estimated capital cost is £56,000.

The Research Association will be electing its Council in the very near future, after which the appointment of a Director of Research will be considered.

The temporary headquarters of the British Industrial Biological Research Association Ltd., are at 11, Green Street, London, W.1. (Telephone: Mayfair 8971).

(D.S.I.R. - Press Notice.)

BRITISH INSECTICIDE AND FUNGICIDE CONFERENCE

The British Insecticide and Fungicides Conference will be held at Brighton, England, from 7th - 10th November, 1961, under the auspices of the Association of British Manufacturers of Agricultural Chemicals.

Papers on the following subjects will be presented at the Conference:-

(a) Systemic insecticides including their use for virus control (to cover mainly potatoes, sugar beet and possibly brassicae).

(b) Soil pests and diseases of agricultural crops (including their control by soil applied chemicals and dressings).

(c) Forecasting of pest and disease outbreaks, spray timings and economics of control.

(d) Potato blight and its control.

(e) Control of apple mildew.

(f) Pests of tree fruits (principally control of red spider mite and tortix species, including codling moth).

(g) Control of Botrytis diseases (with special reference to strawberries, lettuces, flowers, bulbs and tomatoes).

(h) Control of fungi and nematodes in horticultural crops by soil sterilizers.

(i) New developments including new compounds, novel formulations or new application methods.

(j) Translation of research into practice - the introduction of insecticides and fungicides into agricultural practice at home and abroad.

Scientific workers, in the United Kingdom or Overseas, carrying out research in any of the above subjects are invited to make contributions at the Conference. Those wishing to make contributions are asked to send short summaries indicating the scope of their papers to Mr. W. A. Williams, Secretary, ABMAC., Cecil Chambers, 86 Strand, London, W.C.2. before 31st March, 1961.

Registration forms for the Conference will be available shortly, and anyone wishing to receive these should apply to Mr. W. A. Williams, (86, Strand, London, W.C.2.)

(Press Notice issued by Association of British Manufacturers of Agricultural Chemicals. 3rd Jan. 1961.)

PEST CONTROL RESEARCH IN THE U.S.A.

1. Surveys of Foreign Insect Pests to Provide Worldwide Benefits: Technical assistance by the United States in insect survey and detection programmes is being made available to several countries of the Middle East, South Asia, and Africa, through the United States Department of Agriculture. Work done in these countries to catalogue crop-damaging insects is expected to aid plant-protection efforts throughout the world.

Joseph W. Gentry, an entomologist of USDA's Agricultural Research Service, will join an 11-man team now assisting in development of effective organisations and control programmes in these countries. Mr. Gentry will be stationed in Tunisia and will be particularly concerned with the insect problems of that country. In addition, he will assist the other countries, upon request, to develop better means of obtaining precise information on their crop pests. Such knowledge is basic to crop protection, prevention of spread of harmful insects, and detection of newly introduced pests.

Insect-control programmes are under way in Afghanistan, Ethiopia, Iran, Libya, Sudan, Tunisia, Turkey and Pakistan. Since 1951, the International Co-operation Administration of the United States Department of State has furnished funds and USDA has carried out the programmes in these countries. Under the plan, key local people are trained to carry on plant-protection work in their own countries.

More knowledge of the appearance, habits, and damage done by foreign insects will help ARS plant quarantine workers keep these pests out of the United States. The work will aid U.S. insect detection workers in finding such pests should they manage to get into this country. It may uncover valuable insect parasites and other natural enemies of pests. Such information would help entomologists everywhere to develop improved control and eradication methods.

Plant-destroying insects of the Middle East and Africa considered most likely to cause havoc if they invade this country include the senn pest of small grains, the durra stem borer of corn and other large-stemmed grasses, the Mediterranean fruit fly, the olive fly, the white garden snail, the spiny bollworm of cotton, and the Baluchistan melon fly.

Mr. Gentry recently spent three months in the Middle East in an initial effort to assist in establishing a uniform and efficient survey system in each country and to co-ordinate insect survey activities between countries.

In most of the countries involved there is need:

(a) To establish large and complete insect collections, records, and libraries maintained by trained taxonomists or other entomologists who can identify material submitted to them. Such collections are usually placed at museums or universities. Several countries such as Libya, Pakistan, and Sudan, already have well organised national collections of native insects; in other countries, there is still need for bringing together and identifying the collections that exist so as to augment their national collections.

(b) To train economic entomologists, including taxonomists, both locally and outside the countries, since most Middle East and African countries are short of trained personnel. In the meantime, these countries will of necessity, have to depend upon specialists in Europe and the United States for taxonomic support of their survey, quarantine, and control activities.

(c) Through schools and local demonstrations to train farmers, agricultural agents and teachers, workers in plant quarantine, pest control, and other phases of agriculture, as well as public health personnel, in observing, collecting, and reporting insect pests.

(d) To set up channels for a continuing exchange of information on insect pests within and between countries.

U.S. technical assistance in insect control began in 1951, in areas around the Mediterranean, with emergency assistance in combating huge swarms of locusts (grasshoppers). It was applied to the control of other insect pests in 1954. When a plant quarantine specialist joined the programme in 1957 the plan was broadened to include more basic, long-term aspects of plant protection.

(U.S. Dept. of Agric. Press Release 2739-60, Sept. 1960.)

2. **Insect Stress Tolerances:** Insects can tolerate the stress of thousands of times normal gravity (g) with rapid acceleration or deceleration, USDA entomologists find.

This characteristic, together with their ruggedness and less stringent environmental requirements, makes them suitable for gaining biological information from space where more sensitive organisms might perish.

Earlier tests (Agr.Res.Feb.1959,p.7.) has shown that fruit flies survived and responded under stress of 10 g's. Now researchers W. N. Sullivan and T. R. McCauley find that 50% of confused flour beetles survived when subjected to 20,600 g's for 73 minutes. Other insects tested did not stand as much stress; houseflies had 50% survival under 11,400 g's for 2 minutes and Japanese beetles the same rate of survival under 6,250 g's. Man is reported to be injured after a short exposure of 18 to 45 g's.

The insects were placed in tubes in a refrigerated centrifuge equipped to produce high speeds. The tubes reached maximum speed in 90 seconds and decelerated in approximately 3 minutes. After the test the insects were placed in a container with food. The insects that died during centrifuging and during a short period after (for flies the period was 1 day, for beetles 10 days) were considered to have died from the test, most of the deaths occurred during centrifuging. Survivors were apparently normal in appearance and behaviour.

Studies are continuing on the ability of insects to withstand other stresses, such as high vacuum, which would be encountered in space flights.

(Agricultural Research, Sept. 1960, 9, (3).)

3. **Aphid Studies on Beet:** Table beet seed crops are attacked regularly by the green peach aphid - *Myzus persicae* (Sulz.) - and by the bean aphid - *Aphis fabae* Scop. No definite knowledge about the kind and amount of damage to the seed crop caused by the aphids is available. Therefore growers usually apply aphicide sprays or dusts whenever the pests become obvious.

The need for information on the relationships between aphid populations and beet seed losses, and between numbers of aphids and their natural enemy predators - ladybird beetles - instigated a preliminary study of the general problem.

These preliminary studies indicate that the ratios of ladybird beetles to aphids should be high when beet plants begin to bolt during April and May, in order to prevent extensive crop damage by aphids.

Flight Activity: Five aphid traps were operated in the untreated part of the field under observation, to determine the duration and intensity of the major flights of the two species of aphids during the growth period of the beet seed crop. The traps were enamelware pans filled with a dilute aqueous solution made yellow by potassium chromate - yellow is attractive to aphids - and were sunk to half-depth in the soil, at intervals along central untreated plant rows. Trapped aphids were collected at weekly intervals and the numbers of each species were totalled for the five traps.

The migratory flights of the aphids began during the latter part of October and ceased during the winter months. The incoming winged aphids established colonies throughout the beet field. Flights were resumed in March and continued until the end of June.

Green peach and bean aphid flights nearly coincided in duration and periods of peak migration. During the fall flight period, the green peach aphids were more abundant except in October. In the spring flights, winged forms of both aphid species were almost equally abundant. However, there was a noticeable preponderance of bean aphids in May. The heaviest flights of both species occurred after the populations of wingless aphids on the host leaves had begun to decline. The several peaks in the flights suggest that there may have been 5-6 generations of both species of aphids within the growth period of the seed beets planted in September.

(California Agriculture, 1960, *14*, (10).)

4. **Biological Control With Indian Wasp:** The pea aphid - *Macrosiphum pisi* (Kaltenbach) - frequently causes great damage to the spring alfalfa crop in southern California.

In central California, populations of the pea aphid infesting alfalfa usually do not reach outbreak proportions because, during the spring in particular, the aphid is suppressed by natural enemies - principally, ladybird beetles and a fungus disease.

However, the pea aphid is found in California wherever leguminous crops are grown and sporadic outbreaks do occur and severe damage can result.

Early in 1958, a small parasitic wasp *Aphidius smithi* Sharma and Rao - was identified as being largely responsible for the natural control of the pea aphid in India. The Entomology Research Division of the United States Department of Agriculture imported the Indian wasp and supplied breeding stock to the University of California for propagation in the biological control insectaries at Albany and Riverside. Releases of the wasp were started in California alfalfa fields in May, 1958 and by May, 1960 more than 220,000 parasites of the pea aphid had been released.

The wasp from India readily became established in several coastal valley alfalfa fields in 1958, and by the following spring the colonies were spreading rapidly into surrounding fields. In the fall of 1959 the parasite was exerting considerable control of the aphid in most colonized coastal valleys. Surveys in the spring of 1960 revealed the Indian wasp to be widespread in the coastal valleys from north of the San Francisco Bay Area south to San Diego and in many interior valleys, including the desert regions of southern California. In the coastal fields the imported wasp was exerting a dominant role among the natural enemies in the biological control of the pea aphid. The parasite became so abundant that great numbers moved inland where conditions permitted. In southern California, Indian wasps were found in all alfalfa fields in the Coachella Valley, Imperial Valley, Borrego Valley, across the desert to Blythe in the Palo Verde Valley, to Winterhaven, California and into Yuma, Arizona.

Presumably the coastal valley fields will serve as the breeding grounds from where the wasps will disperse to invade the interior valleys. The absence of the pea aphid in the inland valleys during the summer does not enable the parasites to survive in sufficient numbers to become permanently established. The Indian wasp is not known to attack any alternate host aphid species, which limits its activity when pea aphids are absent.

(K. S. Hagen & E. I. Schlinger. California Agriculture, 1960, *14*, (9).)

5. **Parasite of Walnut Aphid:** Imported from France in 1959, a tiny wasp *Trioxys pallidus* Haliday- a natural parasitic enemy of the walnut aphid-*Chromaphis juglandicola* (Kaltenbach) has become established, at least locally, in California.

The wasp was found attacking the walnut aphid in southern France and parasitized aphids were sent to California insectaries for propagation.

During the last six months of 1959 more than 12,000 parasites were reared in the insectaries and released on aphid infested English walnut trees in several countries.

(California Agriculture, 1960, *14*, (11).)

6. **Presence of *Rhipicephalus evertsi*:** The red tick, *Rhipicephalus evertsi*, carrier of several foreign animal diseases such as East Coast fever, was found recently in Florida and New York.

This is the first time the species, common to Africa and also a carrier of cattle tick fever, has been identified in North America, according to ARS scientists.

State-Federal livestock disease eradication officials first found the red tick on zoo animals in a 160-acre wild-animal compound in the south-east corner of Palm Beach County near Boca Raton, Fla. Shortly after, the tick was found on 7 of 10 zebras in a private zoological garden near Tampa, Fla., and on 2 of 3 zebras at a game farm near Hudson, N.Y. These animals were part of a shipment of zebras that originated in Kenya, East Africa. The animals were en route 28 days and underwent a 30-day quarantine in the U.S. before release to zoos.

(Agricultural Research, Dec. 1960, 9, (6).)

7. **"Glypure":** Another synthetic sex attractant has been prepared by chemists of the U.S. Dep. Agric. This one, known as "Glypure", is a powerful gypsy moth attractant. It is characterised as 12-acetoxy-1-hydroxy-*cis*-9-octadecene. The natural form has been identified as an ester alcohol (dextrorotatory 10-acetoxy-1-hydroxy-*cis*-7-hexadecene). The synthetic compound possessing this structure is identical in every respect with the natural attractant, except that it is not optically active. It can be made by starting with ricinoleyl alcohol, an inexpensive chemical that became available commercially, or ricinoletic acid, a major constituent of castor oil.

"Glypure" has been tested in field traps and proved equal to the natural lure even when used in quantities as small as one microgram per trap. In the present Federal State campaign against gypsy moth, a serious pest of shade and fruit trees, traps are baited with a crude form of the natural attractant obtained from segments of female moths. Use of this attractant has been the only reliable way to determine the location and extent of gypsy moth infestations and to check the effectiveness of chemical sprays used against the insect. Infestations occur in New England, New York, and Michigan.

Obtaining enough of the natural attractant has become increasingly difficult. It has been necessary at times to depend on imports from Europe. Collecting and preparing the natural attractant is expensive and time consuming. In efforts to identify this material chemically and produce a synthetic form, Dr. Jacobson and his fellow workers had to use parts of the bodies of half a million female moths to obtain a single drop of the pure natural attractant.

(United States Department of Agriculture, Press Release.)

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

"Pisatin": A new kind of anti-fungal compound has been isolated from peas. It was identified during the course of research aimed at discovering why some plants resist disease while others are susceptible.

The new compound has been named "Pisatin" and is the first of the substances known as phytoalexins to be isolated and characterized. Although it occurs only in small amounts, sufficient of the substance to enable its structure to be determined was obtained by processing the produce from an acre of peas.

Further investigations suggests that each plant produces a characteristic but chemically different phytoalexin in response to infection. However, in any one plant the same phytoalexin is produced regardless of the nature of the fungal attack.

Growth of Detached Insect Tissue: Tissues have been kept alive and growing for long periods after removal from living insects. This is a step towards the continuous growth of insect tissues, already achieved for plants and higher animals. The new technique should prove extremely useful and should have important applications in the solution of a wide range of insect problems. Some of the experimental tissue cultures lived longer than the insects from which they had been removed.

(Commonwealth Scientific and Industrial Research Organisation. Twelfth Annual Report, 1959-60.)

AUSTRALIA - QUEENSLAND

Tobacco: Queensland tobacco growers have to contend with pests which attack the roots, stems and leaves of the growing plants. Some of these pests are present on most farms every year and, even on new farms, it is almost impossible to grow a payable crop without the use of suitable control measures.

The following programmes outline routine preventive practices for seedbeds and early crop growth in the field, and indicate where observations should be used to regulate later treatments:

In the Seedbed: Prepare the seedbed site early and eliminate as many weeds as possible.

Before planting, sterilize the beds and paths by firing or fumigating to ensure nematode-free transplants.

After planting, spread a layer of medium grade river sand to a depth of one-eighth of an inch on the beds as a protection against seedharvesting ants.

At the time of seedling emergence, search the beds closely for activity of leaf-harvesting ants. If this is evident spray the beds and paths lightly with endrin or dieldrin, and give the nests additional spray.

Two weeks after germination, or earlier if necessary, make light sprayings weekly with either endrin or dieldrin. The spray should be directed horizontally from each side and applied after the last watering for the day. A day before lifting for transfer to the field, give the seedlings a thorough spraying with either endrin or dieldrin.

In the Field: Prepare the fields early to eliminate weeds and obtain a good tilth. To control nematodes, fumigate the soil with either EDB or DD at least three weeks before planting out.

For three weeks after transplanting, make weekly applications of a combined spray of either endrin and DDT or dieldrin and DDT.

Later spraying should be timed by observations on the presence of young stages of the pests. Applications of endrin at approximately 10 day intervals should prove sufficient if looper is present. DDT at weekly intervals is required while budworm is active: the DDT should be combined with endrin if looper also is present.

Crops planted for autumn picking should be given the early routine protection. Subsequent insecticide requirements are usually much less than those for fields harvested during the summer.

In south-western districts, jassids are kept in check by the routine spray applications while mites may be controlled during periods of activity by fortnightly applications of "Kelthane".

Nematodes must be considered early. Where soil working can be done carefully during the early life of the crop, the fumigant may be applied in rows 6 in. on each side of the intended planting line. Application in rows 1 ft. apart over the whole field, however, permits maximum lateral working of the soil. The double row treatment requires 10 gal. of fumigant to the acre, the complete treatment 20 gal. In each case the depth of application should be 6 to 9 in.

During recent seasons, leaf-miner activity has been high on some farms, and difficulties have been experienced in dealing with the pest in these proportions. Insecticide trials have been carried through with a range of new materials. The most promising of these is WL 1650, a close relative of endrin. This material killed leaf-miner more quickly than standard recommendations but information in respect to other pests is incomplete. WL 1650, therefore, may be of special value as a spot treatment for leaf-miner control should high activity be suspected or evident. It can be combined with DDT, endrin or dieldrin as required if other pests are present.

Either endrin or dieldrin will control the looper, leaf-miner stem-bore and cluster-caterpillar, but neither gives sufficient control of budworm. DDT will control budworm and also the other leaf and stem pests except the looper. WL 1650 will control leaf-miner.

Weekly applications may be required to control heavy and persistent infestations of leaf pests. On no account, however, should it be necessary, nor is it advisable, to apply insecticides to tobacco more often than weekly, or at strengths greater than recommended.

Effective control of leaf-miner and looper depends to a large extent upon the method of application. Complete cover of both leaf surfaces is essential. This can be achieved only by using sufficient volume of insecticide, and paying particular attention to nozzle placement.

When budworm is prevalent the spray treatments, whether with DDT alone or as a combined spray, should be applied to protect the plant hearts. If this pest only is active, more rapid and economic protection can be obtained by confining the DDT to the upper portions of the plants.

Insecticides are in emulsion form; spray strengths recommended are:

(1) Endrin 0.05% active ingredient

(2) Dieldrin 0.05% active ingredient

(3) DDT 0.1% active ingredient

(4) WL 1650 0.1% active ingredient

(5) Kelthane, 0.05% active ingredient

In any combined spray, each insecticide should be used at its recommended strength. Soil fumigants and dosage rates are:

(1) EDB, 27.0% w/v or 12½ v/v.

Treatment 6 in. each side of intended row position - 10 gal per acre, applied as 1 pint from each outlet of the machine to 4 chains. The same rate is used if 20 gal per acre are applied in rows 1 ft apart across the field.

(2) DD - The material as commercially supplied is used at the same rates as for EDB.

Warnings: To avoid the risk of undesirable taints and residues, insecticides should be used on tobacco only when necessary. Dieldrin, endrin and WL 1650 should not be used in excess of the recommended rates, particularly near harvesting.

A health risk is involved if dieldrin, endrin and WL 1650 are inhaled, ingested or absorbed through the skin. Care should be taken to avoid inhaling these insecticides or being unduly wet by spray.

EDB and DD are skin irritants. Fumes from EDB in a poorly ventilated room are dangerous. Splashes of the concentrates should be washed off immediately with soap and water, and any clothes which are splashed should be changed immediately and not worn again until they have been washed thoroughly.

Scientific Names of Pests:

Budworm	*Heliothis armigera* (Hubn) *Heliothis punctigera* Wallengr.
Cluster-caterpillar	*Prodenia litura* (F)
Leaf-miner	*Gnorimoschema operculella* Zell.
Looper	*Plusia argentifera* Guen.
Mite	*Vasates lycopersici* (Massee)
Seed and leaf-harvesting ant	*Pheidole anthracina* Forel
Stem borer	*Gnorimoschema heliopa* (Low)
Root-knot nematodes	*Meloidogyne javanica* (Treub) *Meloidogyne incognita* (Kofoid and White)

(W. A. Smith and G. W. Saunders. Queensland Agric. Journal, 1960, *86*, (7).)

Oriental Fruit Moth, *(Cydia molesta)*: The oriental fruit moth, also known as oriental peach moth and peach tip moth, is a small greyish moth. The larvae causes damage by tunnelling into fruit and damaging the young growing shoots of peach trees. The damage to fruit is very similar to that caused by codling moth. The pest can infest a wide range of fruit trees including apples, pears, apricots and plums.

The life cycle starts with the adult moths emerging from over-wintering cocoons buried in the soil or hidden in ground debris or under the rough bark of tree trunks. The cocoons shelter the larvae, which change into pupae about four weeks before the adult emerges. The first moths emerge in early September, and the over-wintering generation may continue to emerge until the end of October. The small greyish moth is about half an inch across the fully outstretched wings and the body is only about ¼ inch long. Moths can be identified by narrow whitish markings on the front margins of the forewings. Moths are rarely seen in the orchard during the day.

The female moth lays her eggs on smooth stems or the under-surfaces of leaves, usually near the tip of a shoot or near a fruit. The eggs, laid singly, are only about 1/32 of an inch in diameter and are round or oval in outline and slightly convex. Each female lays from 100 to 200 eggs, and only about 2-5% of these eggs fail to hatch. The eggs hatch in from five to ten days. The young larvae are very active and may crawl several feet in a short time. They test various sites before tunnelling into twigs or fruit. While testing or tunnelling, the larvae bite out mouthfuls of tissue and discard them. This continues until the larvae are entirely buried, when feeding commences.

Twigs are usually entered at the tip, often through a leaf stalk, but older larvae may enter a new shoot below the tip, at a leaf axil. A larva may attack several tips in the course of feeding. The tunnelling may extend as much as 3 inches down into the shoot causing the tip of the shoot to wilt and die. Early in the season, while tips are growing rapidly, larvae have a preference for these young shoots.

When fruit is attacked, the larvae usually enter at the stem or where a leaf or twig touches the fruit. On entering, the larva tunnels its way through to the stone. As far as is known, a larva does not leave the fruit to attack another. When fully fed the larva is about ½ in. long and whitish or pale pink in colour, with a brown head. A tiny five-toothed, comb-shaped plate on the last segment of the body serves to distinguish it from the codling moth larva. Once it is fully fed, the larva leaves the twig or fruit and seeks a place to spin a cocoon. Early and mid-season broods usually spin their cocoons high in the tree, but those of the hibernating generations make their way down the tree to spin cocoons. The latter are thicker and stronger than those of the earlier generations and are usually spun in rough bark on the trunk or right away from the tree, in the shelter of debris or crevices in the soil.

Moths of the first generation, which develop from the eggs of the over-wintering generation, begin to emerge in November. As all the later broods overlap one another, there may be eggs, larvae, pupae and adult moths present at the same time in an orchard from September until April. The complete life cycle in summer takes about 35 days, and there may be up to six generations in a year.

Chemical Control: Spraying is important for good control. Because of the habit of the larvae in discarding the first mouthfuls of tissue, an effective contact insecticide is essential.

Spraying should start early in October to prevent build-up of the early generations. Sprays should be applied thoroughly at monthly intervals. The tops of the trees must be the main aim of the spraying during spring and summer. Late in the season it is important to achieve good coverage around and between the fruits which may be in close contact. Regular spraying is particularly important, because the tips and fruit grow away rapidly from the spray residues. Neglect of spraying early in the season will allow rapid build-up of the moth, making control very much more difficult later on in the season.

Gusathion at 0.05% is the most effective material to use. Elsewhere, DDT at 0.1% has been very effective in the past; but resistance to DDT is now suspected in some areas. Moreover, the use of DDT is likely to result in a serious build-up of mites; and therefore it would be necessary to use an effective miticide as well to keep the mites under control.

(R. L. Wishart. Journal of Agriculture South Australia, Aug. 1960, *64*, (1).)

AUSTRALIA - WESTERN

Agricultural Pest Control

Grasshopper: For several years past aerial spraying experiments have been conducted to test the practicability of this method for combating grasshoppers. Early trials showed that dieldrin was an outstanding insecticide and that it could be applied effectively from the air. Subsequent trials have been designed to find the most economic way of applying the material, special attention being paid to the rate of active material per acre and the quantity and type of liquid carrier. Trials were conducted in mid-September on two heavily infested areas in the vicinity of Southern Cross. Some of the hoppers had reached the flying stage but the majority were in the last nymphal instar. The trial was designed to test the efficiency of the "Micronair" type of equipment on a tiger-moth plane and its suitability for administering the water and distillate preparations of dieldrin. Water treatments were applied at 100 particle size at rates varying from one gallon to a quarter of a gallon per acre. Distillate was also applied at 60 particle size at rates of one gallon to a quarter of a gallon per acre. In both treatments a swathe width was varied from one chain to half a chain. Very satisfactory kills were obtained in all treatments although some migration into the area occurred later from adjacent heavily infested paddocks. The results of this season's experiments indicate that two ounces of dieldrin in a quarter of a gallon of water or distillate can be distributed effectively from a moth aircraft, with Micronair attachment, flying in chain strips. This means that such an aircraft could treat 180 acres in one take-off.

Cockchafer Beetle: Serious damage from cockchafer grubs was reported in the Kojonup-Boyup Brook area during the winter of 1955 and since then the pest has been recorded from several districts in the south-west and the great southern where it is assuming serious proportions. Early trials with insecticides at very heavy rates per acre produced little effect upon well developed grubs, and treatments were applied in the autumn of 1958 to test the effectiveness of chemicals applied to the bare soil before the winter rains and prior to egg laying by the female beetles. Sampling of the plots this winter showed that very good control had been obtained from a number of insecticide treatments, particularly dieldrin. Further work is planned to test the lowest rates which will give satisfactory control and the practicability of applying such treatments on a field scale.

Webworm: Webworm outbreaks were very serious this year and further experimental treatments were applied to crops and pastures. Of the various new insecticides tested none was superior to DDT. Circulars were prepared for distribution to farmers in order to obtain detailed observations on the incidence of webworm and to correlate insect activity with cultural treatments.

Fruit Fly: Further trials with ethylene-dibromide for the fumigation of fruit affected with fruit fly were carried out, as a result of which satisfactory recommendations were available for the fumigation of fruit prior to movement into the southern areas and for the fumigation of citrus. More trials were made with various fruit fly baits and as a result the usual malathion yeast extractions and malathion sugar proportions have been recommended as alternatives to the standard sodium fluosilicate bait. Trials with "Dipterex" have shown that cover sprays of this material will give effective protection to stone fruits. Some 43,000 fruit fly parasites obtained from Hawaii through the co-operation of the C.S.I.R.O. were released at 11 different localities in Western Australia. Four *Opius* species were involved, viz., *O. oophilus*, *O. incisi*, *O. vanderboschi* and *O. longicandatus*.

From fruit samples taken so far 86 parasites have been recovered all from the Gosnells and Maylands release areas with the exception of one *O. incisi* all the recoveries were of *O. longicandatus*. A Queensland entomologist who recently toured Hawaii and the United States to investigate development in fruit fly control methods visited Perth to discuss the fruit fly problem and to pass on information concerning the work which he had seen during his trip abroad.

San José Scale: The life-history and general ecology of this pest has been intensively studied during the past season in view of its great importance to export apple growers. Field trials have been carried out with various insecticides and demonstration treatments have been applied in several districts to indicate the great importance of correct spraying techniques. Trials have shown that in addition to the routine dormant applications of lime sulphur or oil, organic phosphates, such as "Gusathion", diazinon or parathion are useful additives to both summer and winter oils.

Disease Control

Cereal Root Rot: Preliminary results from a long term experiment commenced at Avondale research station in 1958 indicate that wheat seedling establishment may be improved by seed treatment, especially on scarified ley ground. Organic mercury seed protectants were superior to copper for this purpose. There is evidence that parasitic fungi are not necessarily the only cause of this condition as a non-parasitic seed transmitted factor has been responsible for poor emergence in some cases.

Fruit Scab: Pear trees which were sprayed before leaf fall in autumn two years ago with an eradicant PMC fungicide (0.1 per cent) for the control of scab, are still free of this disease although no further fungicidal sprays have been applied since that time. Further tests have been made with captan and a mixture of captan plus PMC applied at the blossoming period to selected pear varieties. Good control of the disease has been obtained with no obvious reduction in fruit set.

Celery leaf spot: In autumn 1958, eight fungicides were tested for the control of celery leaf spot which is the most serious disease of this crop. Bordeaux mixture 4:4:40 was the most effective fungicide, but it has the disadvantage of discolouring the foliage thereby detracting from the market value of the produce. Further trials with split schedules are being carried out in which Bordeaux mixture will be replaced a few weeks before harvest with non-discolouring fungicides.

Sclerotinia rot: Sclerotinia rot continues to cause heavy losses, particularly in late plantings of beans in gardens adjacent to Perth. Experiments on possible avenues of control have shown that PCNB as a preplanting soil fungicide and "Phygon" as a cover spray are ineffective. Very marked reduction of sclerotinia was obtained by deep trenching (sig. at 0.1 per cent. level) and some reduction was also obtained by hand weeding and inter-row cultivation.

Nematode control

Apple: Soil fumigation with DD and EDB before replanting an old apple orchard four years ago is still promoting considerable improvement in tree growth and vigour. Trials in which Nemagon has been applied to living apple trees at the Stoneville research station are already showing beneficial responses. Further trials of this type with Nemagon have been initiated in the Manjimup area.

Banana: Previous work has shown that many banana plantations in the Carnarvon area are heavily infested with eelworms, particularly *Meloidogyne spp.*, *Pratylenchus spp.* and *Radopholus spp.* The extensive rotting of the roots which results from infestations causes reduced yield and premature decline. A number of trials have been initiated in which Nemagon is being tested on living banana plants. Preliminary results are promising.

Tobacco: Serious damage to tobacco crops at Manjimup from root knot eelworm was reported for the first time during the year. Experiments to test the effect of preplant fumigation with EDB have been initiated.

Argentine Ant

6,105,910 gallons of dieldrin and chlordane spray were applied during the season at the rate of 141 gallons per acre. The rate last year was a little over 100 gallons per acre and the increase indicates the difficult nature of much of the country sprayed. The average rate of spray for all Wanneroo (swampland) treatments was 380 gallons per acre and in certain situations up to 1,200 gallons per acre were applied.

One-half per cent. dieldrin was mainly used. Approximately the same volume of two per cent. chlordane as in previous years was applied in connection with restricted spraying where pets or stock were involved.

(Annual Report of the Department of Agriculture for Year Ended 30th June 1959.)

Tobacco: Treatment of Seed Beds with Methyl Bromide. It is an advantage to treat the soil for the control of weeds, nematodes and diseases prior to sowing. One of the most effective agents for controlling weeds, nematodes and diseases is the gas, methyl bromide. This chemical can be purchased in 1 lb tins and is used at the rate of 1 lb/100 square feet of seed-bed area. Thus two 16 ft x 3 ft beds could be treated with one pound of methyl bromide. To apply this gas to the soil a plastic sheet is laid over the seed-bed frame and the edges of the sheet are covered with soil in order to make a gas-tight seal. By means of a rubber tube which is passed under the plastic sheet and an adaptor which fits onto the can of methyl bromide, the gas is released under the cover.

The plastic cover, which holds the gas in contact with the soil, is left in place for 24 hours if the weather is fine and the soil is not too wet, or 48 hours if the weather is cold and the soil over-moist. At the end of this period, the sheet is removed and the bed can be planted after 48 hours exposure to the air. The one plastic cover may be used in rotation for treating all beds.

Higher rates than 1 lb of methyl bromide per 100 square feet of bed may be used if the beds sizes and the plastic sheet sizes do not work out evenly. The range between 1 lb of methyl bromide per 100 square ft and 1 lb per 50 square ft is satisfactory except that the higher rates are more expensive.

Other seed-beds treatments which are sometimes used are formalin and allyl alcohol. Formalin is useful for the control of soil-borne diseases but controls weeds and nematodes only to a limited extent. Allyl alcohol is only useful for the control of weeds.

(A. E. Baker, Journal of Agriculture of Western Australia. Vol. 1 (fourth series), (8), 713-715.)

Grape: Powdery Mildew. Powdery mildew is caused by the fungus *Uncinula necator (Schw.) Burr. Oidium tuckeri* which spreads rapidly during showery or overcast weather when conditions are cooler than normal in summer.

Control: The main method of controlling this disease is by prevention, rather than attempting to cure the disease after it has become established. Dusting sulphur, or alternatively spraying sulphur (e.g. "Wetsul", "Cosan", "Spersul", "Microtomic" sulphur, etc.), should be applied as a preventive measure commencing early in the season -

(a) when shoots are 2 in. to 4 in. long;

(b) three weeks later;

(c) immediately after fruit set

Note. - It is convenient to incorporate spraying sulphur with the ziram or thiram sprays which are recommended at these stages for the control of black spot (Anthracnose).

(d) Any subsequent applications of sulphur would be dictated by weather conditions. For instance, whenever showery, overcast, relatively cool weather occurs during the summer, applications should be repeated at about ten day intervals. Spraying sulphur and dusting sulphur are equally effective but in commercial vineyards the foliage has become dense about this time of the year and power dusting probably gives better penetration and coverage than sprays. Dustings at 5 to 10 lb per acre should be made at the first break in the weather, preferably in calm, dry weather.

Sulphur protects vines from powdery mildew, but will not eradicate it, once it has become established. Therefore, it is emphasised that adequate control can only be achieved by adhering strictly to the recommended schedule. To delay the early treatments or to apply sulphur too infrequently during favourable summer weather will increase the powdery mildew risk accordingly. It is pointed out that reliance should not be placed on sulphur acting at a distance and that complete coverage of all green parts is necessary to give efficient protection. Spraying or dusting methods which do not achieve this should be discarded.

(H. L. Harvey, Journal of Agriculture of Western Australia, 1960, *1*, (Fourth Series), (8), 747-749.)

CANADA

Pest Control - General

Search For Safer Insecticides: Many modern insecticides are toxic to men and animals as well as to insects. There is a pressing need to reduce this hazard and great efforts have been made to find chemicals with high toxicity for insects and low toxicity for mammals. By empirical screening of thousands of chemical compounds a few have been found which display the desired differential toxicity. The Pesticides Research Institute at London, Ont., has undertaken a series of investigations to learn the basis for this differential toxicity. First, it studied the intimate physiological and biochemical processes of normal insects and mammals and then determined how certain of these processes were altered following treatment with insecticides. These studies showed that insects and mammals both have mechanisms for potentiating and degrading these compounds. But in the insect the potentiating mechanism dominates over the degrading process, while in the mammal the reverse is true. This insight into the reasons for the differential toxicity of these insecticides led to a new hypothesis concerning their chemical composition. When a group of new compounds was synthesized to test this hypothesis, they were found to possess the differential toxicity as predicted. A rational approach to the search for new insecticides with low hazard has thus become available.

Insect Resistance: Modern insecticides and fungicides have conferred great benefits to agriculture but they have also brought problems. During the past two years, for instance, two important agricultural pests - the codling moth and the onion maggot have become resistant to the insecticides formerly relied upon to control them. Fortunately, our entomologists in Ontario and British Columbia, where these failures occurred, were alert to the possibility of resistance and were able to recommend effective alternatives.

Insecticide Residues: Another increasingly pressing problem is the need to ensure that recommendations for the use of pesticides do not infringe on tolerances established under the Food and Drugs Act to protect the public from toxic residues. Intensified studies are in progress to determine the rate of timing of pesticides applications that will protect the crop from attack by insects and diseases, and still allow adequate time before harvest for the reduction of pesticide residues to allowable levels. More research on the mechanisms that reduce pesticide residues on crops (weathering, growth of plants, metabolism of pesticides) will be necessary to predict safe intervals between application and harvest, and to gain a measure of control over the persistence of pesticides on crops.

Micro-organisms and the Health and Disease of Crops: The common agricultural practice of crop rotation rests on the complex and poorly understood relations between the roots of plants and the bacteria and fungi of the soil. Certain of these soil micro-organisms are deleterious, causing diseases such as root rots; others are beneficial, such as the nitrogen-fixing bacteria of legumes which play an important role in the nutrition and growth of plants. Exudates from the roots of the crop itself may favour or antagonize these effects by stimulating or depressing the growth of certain micro-organisms in the soil.

The programme of the Microbiology Research Institute is aimed at improving our understanding of this basic aspect of crop production. To improve plant nutrition, the genetics of legume bacteria is being studied with the object of producing strains of these bacteria with greater nitrogen-fixing capacity. Recent work has revealed the possibility of incorporating the high nitrogen-fixing ability of certain strains into strains that are deficient in this property. Other work on the nutrition, physiology and metabolism of soil micro-organisms is providing information essential to the ultimate objective of rational manipulation of crops and the associated soil micro-organisms to improve their beneficial and decrease their adverse effects on crop production. Studies on the metabolism of blight - and tumour-producing bacteria are yielding information on how these organisms invade healthy plants and exert their toxic effects. Present evidence indicates that chemical substances produced by the bacteria are responsible for invasion of the plant. If these substances can be isolated and identified, the way will be opened for the development of antagonistic chemicals that may be used for control.

Concern has been expressed that the large-scale application of potent new agricultural chemicals may alter the microflora of the soil, producing for instance, heritable changes that would increase the virulence of plant disease organisms. Reassuring results were obtained in a recent study which showed that treatment with two common herbicides caused no heritable changes in the bacteria causing blight. Genetic studies have also led to the isolation of viruses specific for certain plant disease bacteria, and which can therefore be used for the diagnosis of these diseases. The method is rapid, permitting diagnosis of seed or plant infection within 48 hours instead of four to six weeks by previous methods.

Agriculture:

Wheat Rust: It has earlier been demonstrated in the laboratories of Winnipeg Station that simple compounds of nickel are highly effective in preventing rust infection and in eradicating established infection. This laboratory-finding has now been extended to field trials and shown to be effective and practicable. Thus, we have established a second line of defence against the wheat rust in the event that our first line, resistant varieties, should ever fail. The fundamental studies that yielded this unexpected dividend are being continued and will no doubt afford a deeper insight into the relations between the fungus and its host. On the basis of such knowledge, we expect to be able to make more rational selections of chemicals and genetic material for the protection of wheat from rust infection.

Aster Yellows Disease: Aster yellow is a virus disease which in 1957 virtually ruined crops of lettuce, celery, carrots, and sunflowers everywhere east of the Rocky Mountains, and reduced flax yields throughout the prairies. The disease was known to be transmitted by an insect, the six-spotted leafhopper, but little was known about the habits and life history of this insect in Canada. Studies in Manitoba and Ontario have now shown that the eggs of the leafhopper can overwinter on fall-sown grains, but the large numbers of adults that often appear in the spring are migrants carried, like wheat rust spores, by mass air movements from the Central United States.

A small percentage of these migrants is infected with the virus. The insects multiply rapidly on young grain, grasses, and weeds, some of which also harbour the virus. As these plants mature, the leafhoppers move into susceptible crops and infect them. Extensive trials with insecticides applied to vegetable crops were generally disappointing because of the continuous influx of leafhoppers from the surrounding vegetation. However, two insecticides were shown to give worthwhile protection when applied twice weekly. Thus, the studies have yielded a stop-gap control measure, and much useful information for further research.

Future work will investigate the usefulness of treating large acreages surrounding the susceptible crops, and the value of systemic insecticides which render the plants themselves insecticidal for considerable periods. Another line of attack has been opened by attempts to breed varieties of flax and sunflowers that are resistant to feeding by the leafhopper or to infection by the virus.

Forestry:

Spruce Budworm: The 1959 season was favourable for budworm development in central New Brunswick, and there was a resurgence in some 2.3 million acres along the southern border of the protected zone across the Province. This will require spraying in 1960.

There has been no evidence of DDT-induced outbreaks of other pest species, and parasites and predators have been proportionately less affected by spraying than their budworm host. Adverse effects on young salmon and fish-food organisms of DDT at one-half pound or more per acre led to tests, in co-operation with the Fisheries Research Board, of alternative insecticides and reduced dosages of DDT. Alternative insecticides gave unsatisfactory results, but DDT at one-quarter pound per acre gave effective budworm kill and appreciably reduced injury to young salmon and aquatic insects.

Black-Headed Budworm: Plans have been made by the B.C. Loggers' Association to spray high-hazard areas in 1960, with DDT at one-quarter pound per acre.

Biological Control: Biological methods of control hold special inducements in forest entomology owing to the huge areas involved, the long time between timber harvests, the low unit value of the crop, and the ability of forest trees to tolerate moderate defoliation without serious economic consequences. Considerable research is being carried out on the principles and practices of biological control of forest insects. Long-term studies of defoliating insects and their parasites in New Brunswick have shown that parasites are important regulating factors of the introduced European spruce sawfly and the native blackheaded budworm, and that certain parasites of the spruce budworm, while not preventing serious infestations of the budworm, nevertheless respond to changes in host density with a reasonable degree of predictability. Certain parasites of the European pine shoot moth in southern Ontario are more winter-hardy than their host and are thereby relatively favoured by climatic extremes such as occurred in the winter of 1958-59. Studies of small mammal predators of sawflies have clarified some of the factors, such as prey characteristics, availability and density, and the habits of the predators themselves, that govern effectiveness of predation. A small colony of the long-tailed shrew was transferred to Newfoundland in the fall of 1958 to improve the biotic control of the larch sawfly. Studies in 1959 revealed successful establishment, extensive breeding and multiplication, and gradual dispersal of the shrew from the point of liberation.

Importations of insect predators of the balsam woolly aphid in the Atlantic Provinces and of parasites of the winter moth in Nova Scotia continued in 1959, with encouraging evidence of establishment and dispersal from earlier releases. Search has been undertaken by the Commonwealth Institute of Biological Control for additional parasites of the pine shoot moth, the pine sawfly, and the larch sawfly in Europe.

Research in insect pathology is yielding valuable results. Effectiveness of viruses of the European spruce and pine sawflies was demonstrated earlier. Field studies in 1959 showed that viruses of two native species, the red-headed pine sawfly and the Swaine jack-pine sawfly, can control infestations of the host species when applied as sprays from the ground, and that the disease persists and spreads in the population. Aerial dispersal of the jack-pine sawfly virus is planned in Quebec infestations in 1960. Limited trials by the Insect Pathology Research Institute, of the "bacterial insecticide" produced by *Bacillus thuringiensis*, indicated effectiveness against the hemlock looper and possibility in the control of the black-headed budworm. The bacterial insecticides hold great promise because of their non-toxicity to vertebrate animals. More extensive field trials are planned in co-operation with regional forest biology laboratories in 1960.

Veterinary:

New Insecticides Against Cattle Insects: In a series of large-scale field trials, entomologists at Lethbridge, Alta., and Kamloops B.C., have demonstrated that newly introduced organophosphorus systemic insecticides are highly effective, and have determined appropriate doses and methods of application. A large-scale experiment to determine the possibility of eradicating the warble fly from a large sector of range land is in progress. Enough information has been developed to permit the sale of certain of these insecticides in Canada. However, more research is required to determine, and if necessary eliminate, possible side effects on feed utilization and immunization of animals.

(Annual Report (Agriculture) for Year ended March 1960.)

CANADA - ALBERTA

Grasshoppers: The infested area in southern Alberta increased from 3,110,000 acres in 1958 to 4,150,000 acres in 1959. Of the total infested area, 1,150,000 acres were rated moderate and 3,000,000 acres as light.

Under the grasshopper policy, the Department distributed aldrin and dieldrin insecticides at cost, less shipping and handling charges, through municipal and district offices. The following table shows the 1959 situation and control programme with 1956-58 for comparison purposes:

	1956	1957	1958	1959
Acres of land infested	1,900,000	1,700,000	3,110,000	4,150,000
Acres of crop menaced	2,000	3,000	150,000	500,000
Acres crop destroyed	100	100	200	500
Lbs. tech. aldrin used	200	50	4,250	240
Lbs. tech. dieldrin used			70	10,750
Acres treated	3,000	400	35,500	173,800

The introduction of dieldrin has reduced the cost of spray material from 25 cents to 15 cents per acre.

Cattle Grubs and Lice: Stockmen showed considerable interest in new livestock systemic insecticides. During the spring, grub counts were taken on 12 herds that were test sprayed with 'Co-Ral' the previous fall in 12 districts, to obtain data under farm conditions. Results were tabulated and distributed. The tests indicated that louse control was excellent in all sprayed herds and that earlier fall treatment was superior for warble control. Results varied from 29% control for November spraying to 98% for early October spraying, with an average warble control for the 12 herds of 78.6%. No undesirable side effects were noted.

(Annual Report of the Department of Agriculture for the year 1959.)

CEYLON

Tea

Nettle Grubs: As a result of two reports that 1% 'Teepol' had not proved effective in controlling nettle grubs, a trial was carried out at Nayabedde Estate comparing DDT, malathion, and 'Teepol'. 1% 'Teepol' gave virtually no control. DDT (0.1%) and 0.1% malathion, both in emulsion form, and 0.2% DDT, as wettable powder, gave good control. It is hoped to finalise a recommendation shortly.

White Grubs: An extremely heavy infestation was seen at High Forest Estate, Kandapola, late in December, which aldrin had apparently failed to control; a trial is planned. Little is known about the bionomics of the different species involved, and no progress on this aspect was possible in 1959. Experience in chemical control with aldrin and dieldrin in many parts of the world suggests that they should be highly effective, but a few surprising failures have been reported here, and this urgently requires investigation.

Tea Tortrix: Sixteen outbreaks of tea tortrix *(Homona coffearia* Nietn.*)* were reported during the year. Seven of these followed the use of dieldrin for shot-hole-borer control as a post pruning spray. The remaining group of nine outbreaks, which had nothing to do with the effects of dieldrin, is one of the highest figures for tortrix since the introduction of the parasite *Macrocentrus* in 1935-36. There is no definite evidence that the parasite is becoming less efficient; fluctuations in the degree of control are rather to be expected. The parasite has almost invariably resumed control in a few months.

Mites: Work on tea mites in Ceylon has in the past been limited by the techniques used for assessing mite numbers. Considerable attention has therefore been devoted to this aspect, and work was begun on a technique using a rotary brushing machine. This consists essentially of an electrically-driven brushing device which brushes the mites off the leaves on to a rotating circular plate, five inches in diameter, which is smeared with a suitable viscous medium to trap the mites and eggs. The plates can be stored for some time. First results suggest that this method will be applicable to all four mite species and will make counting easier and more accurate.

Studies were also begun on mite distribution on foliage and on sampling methods, for use in acaricidal field trials and in studying the population dynamics of the mites.

Preparation has been made for studying the action of various acaricides on tea mites, including the attributes of specific toxicity, persistence, toxicity to eggs and also to active stages, and leaf penetration properties. This work involves laboratory as well as field studies, and certain laboratory facilities are being improved.

Attention has also been given to the vital problem of obtaining good spray-coverage on mature tea. One technique for studying spray-coverage involves the use of fluorescent dyes in the spray material; deposits are then shown up in ultra-violet light.

Two trials on the chemical control of yellow mite on an area of young tea (clones K145 and K150) have demonstrated that kelthane and endrin show promise for the control of this species; sulphur is at present recommended, but it taints badly. No practical recommendations can yet be made.

Certain fields on one estate were dusted with 4% karathane dust, four rounds, using a powered knapsack duster. Counts of scarlet mite on treated and untreated areas, before and after spraying, showed a reasonable control except on areas of very steep slope, where it proved impossible to give adequate coverage.

In a small scale replicated trial on chemical control of tea red spider, chlorobenzilate ("Akar 338"), aramite, karathane and kelthane as well as sulphur all showed some promise, but work is required on methods of assessment before further trials can be made.

Two replicated field-trials were begun to investigate the possible effect of copper fungicides on mite numbers and increase, one trial on scarlet mite at St. Coombs, and one on yellow mite at Ferham Estate. Treatments included proprietary copper oxide and copper oxychloride wettable powders, Bordeaux, mixture, a proprietary colloidal copper, captan as an alternative fungicide, and untreated controls. Mite numbers have remained very low until the end of 1959, and no differences have appeared yet.

Shot-hole Borer *(Xyleborus fornicatus, Eich.)*: An average dosage of about 1.3 lb of active ingredient of dieldrin per acre, the lowest of the dosages mentioned, caused considerable reductions in numbers of beetles at 5, 6 and 7 months after a single spraying, provided the spraying was done in dry conditions. No practical recommendations emerge from the experiments described.

Spraying the soil surface with dieldrin sometimes gave satisfactory results in reduction of beetles but at other times it did not.

Other Pests: This report contains details of investigations on the bionomics of tea nematodes particularly the meadow nematode, *Pratylenchus coffeae;* also details of research on diseases of tea, including blister blight, root diseases, and virus diseases.

(Tea Research Institute of Ceylon. Annual Report for the Year 1959.)

GHANA

Capsid Control. Joint W.A.C.R.I./Division of Agriculture Capsid Control Trials: After two full seasons field trials in the Eastern Region (with both small-scale and large-scale units) using endrin, dieldrin, aldrin, "Gammalin" and malathion, a sufficient mass of data has accumulated to make continuation of these trials unnecessary. Dieldrin and malathion have been eliminated for use against capsids, the former on account of the danger of a subsequent increase in *Marmara,* the latter because of sub-standard control at economic dosages. In Ashanti the trials with endrin, aldrin and "Gammalin" at dosages approximately in inverse proportion to the cost will continue.ø

With both series of trials the same general picture appears, as with earlier preliminary trials in 1956 (Rep.W.Afr.Cocoa Res.Inst. 1956-57). Comparing similar dosages of toxicant, endrin is outstanding in its control, "Gammalin" and aldrin being next in order of efficiency. In all trials aldrin is consistently less effective than "Gammalin" but the differences between the two are very small - of the order of 3% difference in the numbers of damaged trees per 1,000 trees. Aldrin has therefore been considered suitable for capsid control in Ghana, provided the retreatment is at the 2 oz rate of application. A full account of this work will be published elsewhere.

(West African Cocoa Research Institute. Quarterly Progress Report No. 53.)

Forest Pest Control

The exotic *Dalbergia sissoo* appears to be highly susceptible to disease and insect attack in this country. A root fungus caused deaths in a plantation of this species at Nangodi in the Northern Region while a fusiform rust attack has weakened it in the Kpong irrigated plantation and this was followed by a borer attack.

In nurseries in the Eastern Region *Triplochiton scleroxylon* seedlings were attacked by *Homopterus* bugs of the family Aleyrodidae but this was brought under control by fortnightly dusting with "Gammalin A" (0.5% gamma BHC) powder. *Terminalia ivorensis* was

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ø Note: In addition yields and pod husk miner damage are now being recorded.

attacked by green fly (Aphids) but this was also successfully treated by dusting with 0.5% gamma BHC dust.

The attack by the fungus *Phaeolus manihotus* on *Cassia siamea* in Achimota plantation still persists and uprooting diseased stumps continued. This policy, now persisted in for 12 years, has undoubtedly slowed down the disappearance of this species from this plantation where it gives considerably higher per acre yields than the resistant Neem, but the habitat is evidently marginal and it must gradually succumb to the fungal attack which here shows no decrease in virulence. This fungus is also present in Inchaban and Kumasi Town Cassia plantations but there where the Cassia is much more vigorous under higher rainfall conditions deaths caused by the fungus are negligible.

(Annual Report of the Forestry Department for the Year 1958).

INDIA

Wheat Rust Control: In a comparative field fungicidal trial with 9 fungicides half a gallon of "parzate" liquid (19% disodium-ethylene-bis-dithiocarbamate) plus three quarters of a pound of zinc sulphate per acre sprayed four times during the crop season at an interval of a fortnight beginning in the first week of February reduced the rust infection from heavy to traces, with corresponding increase in yield.

(Commonwealth Phytopathological News. Oct. 1960. 6. (4), 61.)

Wood Preservation: The work on the treatment of green canes by diffusion process using boric acid, zinc chloride, "Ascu" and "Basilit U.A. Special" was completed. It was found that satisfactory absorptions can be had with a 2% solution of the above preservatives in about two weeks time.

Detailed work on the leaching of zinc chloride and copper sulphate under different conditions was taken up, using *semul*, mango, deodar, *chir*, teak and sal blocks of different sizes and varying the number of shakes. The results are being analysed. In a similar way, fixation of preservatives like "Ascu", boric acid and arsenic pentoxide in grass, cane ropes, cane, gunny and khaddar cloth treated with the above preservatives has been carried out. It is found that with the preservatives tried, best results were obtained with "Ascu"; best fixation was obtained in canes, the next best being in khaddar.

Large scale preparation of copper and zinc preservatives from pine resin was taken up. Test blocks treated with the above preservatives were being sent to the mycology branch for carrying out toxicity tests. Experiments have also been initiated to prepare similar metallic preservatives of mercury, nickel and arsenic.

Three species of bamboos, viz., *Dendrocalamus strictus, D. longispathus, B. polymorpha*, were treated on a large scale using "Ascu", zinc chloride, borax-boric acid and sodium pentachlorophenate. These were then exposed to insect attack:- *Dinodorus oscellaris, D. minutus* and *Lyctus africanus*. It was found that the attack stopped when the absorption of the preservative was beyond about 0.23 lbs/cu ft in "Ascu", 0.27 zinc chloride, 0.45 borax-boric acid and 0.43 sodium pentachlorophenate.

Palmyra palms were treated with Creosote and "Ascu" in 1940 and installed in the test yard. Chemical analysis showed that even after 16½ years sufficiently large quantities of preservatives are left behind. They can be expected to last another ten years.

(Forest Research in India 1956-57. Part 1 The Forest Research Institute, Delhi, 1960.)

NEW ZEALAND

Agriculture

Pastures: DDT and potash are being more extensively used with consequent increased pasture growth. Pests such as grass grub and subterranean caterpillar are however, still prevalent in some areas.

Maize: Some serious damage to maize stored in cribs has been caused by a new pest, the Angoumois grain moth *(Sitotroga cerealella)*, and methods of control are being investigated in association with the Entomology Division of the Department of Scientific and Industrial Research.

Pip Fruits: All three species of red mite were major pests in 1959, especially in South Island districts. Prevention of summer build-up is being constantly stressed by departmental officers and most fruitgrowers now take early control measures. Mealy bug *(Pseudococcus maritimus)* was a serious pest on pears and apples in Hawke's Bay and its presence called for the utmost vigilance in the preparation and inspection of export fruit. Apple leaf hopper *(Typhlocyba australis)* was much in evidence in several districts. Much injury to pear foliage was caused by pear midge *(Perrisia pyri)* in orchards at Hastings and Te Kauwhata. Severe infestations of parlatoria scale *(Parlatoria pergandei)* were found on fruit in some Marlborough apple orchards.

Heavy rainfall and high humidity in December caused a severe infection of *Glomerella cingulata* in Auckland orchards, resulting in considerable loss of Gravenstein and Granny Smith crops. Some loss of fruit also occurred in Waikato orchards. Powdery mildew *(Podosphaera leucotricha)* was again very prevalent throughout the country. More determined efforts by growers to control this disease will be required if further injury to trees and loss of production are to be avoided. European canker *(Nectria galligena)* is now a serious problem in some Auckland orchards, causing severe injury to both young and old wood of apple trees. Many Kidd's Orange Red trees at Oratia and Henderson are heavily infected. Granny Smith is also very susceptible. Collar rot *(Phytophthora cactorum)* caused loss of apple trees on orchards at Papanui (Christchurch) and in Hawke's Bay.

The incidence of fireblight *(Erwinia amylovora)* was the highest for several years. Outbreaks occurred in pear orchards in most districts, but were more severe in Auckland, Nelson, Canterbury, and Central Otago. "Pink eye", a disease not yet identified, again affected William's Bon Chretien pear crops in Nelson orchards, but loss was much less than in the previous season.

Of the newer therapeutants "Gusathion" and diazinon were used by a number of growers as general insecticides. Diazinon and parathion were used extensively to control mealy bug in Hawke's Bay. Considerable use was made of metasystox against red mite. Other new materials applied for this purpose included "Rogor 40", "Delnav", "Ekatin", and "Tedion". "Melprex", a new fungicide for black spot, was given an initial trial by growers in several districts.

Stone Fruits - Pests and Diseases: Red mite built up toward the middle of the season in Auckland, Nelson, and Canterbury, but elsewhere was not important. The species varied considerably even between orchards in one district: the most important species were *Tetranychus telarius* and *Metatetranychus ulmi*.

Leaf-roller caterpillars *(Tortrix spp.)* caused more damage than usual, possibly because of the favourable season, but increasing resistance to DDD is also suspected.

Earwigs *(Forficula auricularia)* are not satisfactorily controlled by routine sprays for leaf rollers, and where orchards are not baited periodically this pest tends to increase.

Aphids *(Myzus persicae)* were more prevalent than usual in South Island districts. In Hawke's Bay mealy bug *(Pseudococcus sp.)* infestation on peaches is becoming more serious, and in some areas will require special control measures.

San José scale *(Quadraspidiotus perniciosus)* is being well controlled and is now much less of a problem than it was.

In most districts brown rot *(Sclerotinia fructicola)* was well controlled, but caused some losses, particularly in Canterbury, where unfavourable weather occurred just before harvesting of some varieties. The adoption of the temperature control method developed in Australia appears likely to reduce considerably post-harvest losses in canning fruit.

Silver leaf *(Stereum purpureum)* remains the most serious fungus disease attacking fruit, particularly in northern districts. No cure has yet been developed nor can it be completely prevented by even a high standard of orchard hygiene.

Gummosis (caused by *Eutypa armeniacae*), which was first recorded for New Zealand last year in Canterbury, is causing serious loss in two apricot orchards in that district. So far it has not been identified in any other district.

Winter and spring weather favoured a higher incidence of blast *(Pseudomonas syringae)* in southern districts, and in some northern districts bacterial spot *(Xanthomonas pruni)* is becoming more important on peaches as well as on plums. Bordeaux sprays give partial control of both these diseases.

Rain just before harvest caused considerable cracking of cherry fruit, facilitating infection by brown rot.

Bird damage on buds was less serious than usual, and trace element deficiencies were a comparatively minor problem.

In the main apricot district older trees, particularly those on peach stock, are beginning to decline in vigour and are steadily being replaced.

Symptoms of virus diseases were slightly less noticeable than usual.

Some of the newer organic phosphorus insecticides are being used successfully for mite and aphid control on stone fruit, but none of the very new fungicides has been applied on a commercial scale.

Berry Fruits - Pests and Diseases: Freedom from controllable pests and diseases was a notable feature of the season's berry crops. This is attributed to a better understanding by growers of the need to adhere to a routine spray programme and the use of more efficacious spray chemicals, particularly for insects.

Strawberry fruit rots from *Botrytis cinerea* again caused serious losses where rain was experienced during harvesting. Losses in one large garden were estimated at 15 tons. Trials during the year indicated that thiram was the most effective fungicide tested, when applied every 10 days from flower formation to 14 days pre-harvest.

Strawberry root weevil *(Otiorrhynchus ovatus)*, which in recent years has become a major pest and against which there seemed to be no reliable treatment, has been effectively controlled by pre-planting treatment of the soil with aldrin, one application protecting the plants for the life of the plantation.

Virus diseases of strawberries were less evident than in previous years, greater care being taken in the selection of stocks used for propagation, more drastic rogueing of runner beds, and the use of systemic insecticides for the control of the aphids vector in nurseries and in fruiting beds.

Use of Newer Therapeutants: Captan is being more widely used in place of Bordeaux mixture for the control of fungus diseases, especially brown rot *(Phytophthora citrophthora)* and wither tip *(Glomerella cingulata)*. Captan leaves less deposit and is not as injurious to tender growth as Bordeaux mixture.

Diazinon has been used against mealy bug with good results, but when used with captan some russeting of young New Zealand grapefruits was observed. No injury was observed on Meyer lemons with this spray combination.

Tomato: Green aphid *(Myzus persicae)*, white fly *(Trialeurodes vaporariorum)*, and looper caterpillar *(Plusia chalcites)* were troublesome in some tree tomato plantations during the year.

Karathane was used effectively by some growers to control powdery mildew *(Oidium sp.)* on tree tomatoes.

Grape: Powdery mildew *(Uncinula necator)* was more prevalent than usual. Black spot *(Elsinoe ampelina)* was fairly prevalent early in the season, but was prevented from causing much damage by regular spraying with thiram and copper compounds. Downy mildew *(Plasmopara viticola)* was inconspicuous compared with most seasons. Botrytis *(Botrytis cinerea)* caused extensive damage to the bunches late in the season after wet humid conditions. Damage by leaf-roller caterpillars *(Tortrix sp.)* to the grape bunches predisposed much of the crop to botrytis infection. The increase of this caterpillar in recent years suggests that it may have developed a resistance to DDD and lead arsenate sprays at normal concentrations.

Mealy bug infestation was less than previous years, probably due to the season, but it is still serious in many vineyards. Mealy bug has apparently developed a resistance to DDT and possibly some of the organo-phosphate sprays. The destruction of useful predator insects by these insecticides has accentuated the control problem. Sporadic trouble from lecanid scales *(Eulecanium corni and persicae)* has been controlled by oil sprays fortified with malathion.

In most seasons birds cause greater losses to the grape crops than diseases and insect pests combined, and the 1959-60 season was no exception.

Wildlife Control

Sodium monofluoroacetate (1080), arsenic, and phosphorised pollard continue to be the main poisons used. It is pleasing to record a marked reduction in stock losses from the use of 1080. This can no doubt be attributed to a better appreciation by farmers of the need to keep stock off poisoned blocks until risk of poisoning is past, and to boards' using smaller baits and a reduced quantity of 1080 when making up the baits. The smaller quantity of 1080 used, while just as effective in killing rabbits, has reduced the chances of stock getting a toxic dose by eating untaken baits.

Livestock Pests

Because of the continued vigilance of Livestock Instructors at salesyards, there has been a big reduction in the incidence of lice-infested sheep at sales. Under the new methods of tip spraying and dusting for lice control there is need for more advice to farmers that the lice are not immediately killed at the time of treatment. At saleyards lice have been found on sheep which have been tip-sprayed a day or two before. The new insecticides have proved effective for lice destruction, but the techniques of application require to be understood and conscientiously followed. The ultimate aim should be eradication of lice and ticks from the flock.

Parasitology: Surface Application of Insecticides to Sheep for the Control of Keds and Biting Lice: A trial was carried out to determine the length of protection against reinfestation afforded by surface application of dieldrin and diazinon at different dose rates and with different lengths of wool. Protection was tested by placing keds and lice on the treated sheep at intervals of one to two weeks and observing whether the insects survived. The dose rates used were 0.25, 0.5, 1.0, and 2.0g of active ingredient per sheep applied at nil, six, and 12 weeks after shearing.

The results showed that with both insecticides protection from reinfestation by keds increased from 15 weeks at 0.25g to 25 weeks at 1.0g. Little extra protection was given by the 2.0g dose. Protection against lice lasted slightly longer than against keds, and dieldrin gave slightly longer protection against lice than did diazinon. With up to 12 weeks' wool no difference due to length of wool could be detected.

Evidence that strains of sheep blowfly *(Lucilia sericata)* from Marlborough have developed a definite resistance to dieldrin has been obtained, and other strains from the North Island, in which resistance is suspected, are being examined.

(Report of the Department of Agriculture for the Year ended 31st March 1960.)

Forest Pest Attacks

General: Animal pests of many different species are still colonising hitherto uninfested areas. Thus the ultimate pattern and effects of animal occupation must be regarded at present as matters of some conjecture. What appears to have emerged with some clarity is the deleterious effect these animals have on their forest environment when they are present in large numbers, and especially where several species occupy the same area. What is not so certain, however, is the long-term effect on animal populations of the intra- and inter-specific competition that must inevitably result from environmental deterioration. Again, the effect of control measures can be evaluated with precision, in so far as they concern the environment; it is by no means a simple matter to assess the results on the animal populations themselves. The whole noxious animal situation is a complex one, and the many questions as yet unanswered will be resolved only by sustained research. Meantime, the prudent course is obvious - to intensify and extend practicable control measures wherever protection forest damage by noxious animals constitutss a threat to human and economic welfare.

Deer: Kaingaroa Forest has harboured deer for many years and these animals have always caused some damage in young stands. In recent times damage from this cause has increased alarmingly - to the extent that the chances of growing second crops of high quality are being threatened. To cope with the situation a team of 10 full-time hunters has concentrated on the deer population, pastime hunting by other employees has been organised on a year-round basis, and some poisoning has been carried out in a comparatively undisturbed portion of the forest.

Opossum: The sum of £151,905 was spent on opossum control, a 30% increase. In Rotoehu Forest opossums have ringbarked southern pine so extensively that it is difficult in some compartments to find sufficient final-crop trees.

The present bounty scheme, which has returned a kill of about 1,000,000 animals a year, has always been regarded as a temporary measure to be discontinued when more effective operational methods have been developed. Poisoning trials carried out in recent years indicate that in favourable conditions opossum populations can be drastically reduced by this means.

Further sodium fluoroacetate poisoning trials in both exotic and indigenous forests show that large-scale poisoning of opossums is practicable provided that, in the heavier rainfall forests especially, meticulous attention is given to quality, particle size, and the toxicity level of baits.

Goat: Satisfactory campaigns were held in Glenbervie Forest, Auckland, in the headwater areas of the Waioeka and Motu Rivers, and in the Shotover catchment, Southland. This last area illustrates the often repeated pattern of successful operations resulting in one species being severely reduced in numbers but followed by an upsurge of what was a secondary species.

Wild Pig: The subsidy allowed for wild pig destruction campaigns has been increased from £200 to £500 a year; the subsidy may be claimed, too, by farmer committees as well as county councils. The forest service now gives advice to each as well as practical field instruction in control techniques.

Wood Preservation

With a view to encouraging the maximum economic utilisation of woodlots and small forest holdings the Forest Service has endeavoured to develop a cheap, practical, and effective method of preservative treatment. As an improvement on the age-old hot and cold bath treatment the Department developed a suction sap-displacement method. This consists of the application of a vacuum at one end of a green post or pole, while the other end is immersed in a preservative solution. Sap is removed continuously from the wood by the vacuum, and is replaced by preservative, until all the sapwood is treated. The equipment required is simple and consists of a vacuum pump, a number of distribution tubes and caps for the posts, and a preservative reservoir. The first phase of this work was completed in 1959. Posts of Corsican, radiata and ponderosa pines, European larch, Norway and Sitka spruces, Douglas fir, and rimu were treated and practically all the sapwood was penetrated in each case. This project has shown that full penetrations of sapwood are possible and providing the preservatives used will satisfy the TPA requirements there is a tremendous round-produce potential which could be realised by establishing cheap plants based on this method. Seasoning trials for Corsican pine posts show that covering of seasoning stacks is essential under normal conditions. It was also clear that posts treated with a different fungicide prior to the seasoning process were much less susceptible to decay. Further trials will be carried out using a normal anti-sapstain solution which does not diffuse. Effective regeneration in areas prone to heavy frost had been achieved by leaving approximately 12 to 20 trees per acre to provide an overwood shelter which minimised frost damage and so prevented the death of a large percentage of the natural regeneration. While this avoided costly overplanting, it unfortunately presented a high hazard to logging crews and the substitution of strip felling has proved a marked improvement from the safety aspect. Its effectiveness will be watched with interest and other forest owners are invited to study the results.

Insect and Fungal Attack

The Pathological section continued its fundamental work of identifying and studying life cycles of these insects that are already established in the country and most likely to damage forests should conditions allow. The looper caterpillar mentioned in past reports continues as a threat to exotic forests, but has caused no significant destruction this year.

(Report of the Director of Forestry for the Year ended 31 March 1960.)

Tick Control

Cattle ticks are a problem mainly in the warmer areas of Auckland Province, particularly in the Gisborne area and North Auckland, on broken country which cannot always be kept closely grazed. While deaths of animals due to the severity of tick infestation are not common, other losses which are not so obvious may be quite costly. Loss of milk production, ill thrift in lambs and hoggets, and damaged sheep and cattle hides all constitute a real loss of income. The damage to bobby calf pelts alone runs into many thousands of pounds annually.

Factors Governing Success: A very uniform cover must be obtained. The success of the control depends on every inch being covered with sufficient DDT to do the job, since once the DDT is washed into the ground it is taken out of reach of the ticks. With aerial topdressing extra precautions must be taken to allow for wind velocity and prevent overlapping and missed strips. This could perhaps be accomplished by sowing at a slightly reduced rate and having the laps closer together.

Spinner topdressers would also have to close up on laps, 24 ft swaths being the maximum which would give adequate cover. Even with farm topdressers it is very easy to miss parts, especially on corners and along fencelines. Close attention to detail will be rewarded by effective control.

Pasture must be kept under control to prevent surviving ticks from finding suitable cover. Ticks are actually sensitive creatures. Extremes of temperature and either very low humidities or excessive rainfall will adversely affect their spread, which accounts for large variations in tick populations. Without adequate cover they cannot multiply.

Reinfestation from outside must be prevented. Stock introduced into clean areas must be tick free. Fences must be in good order to prevent tick-infested stock from wandering in. Since fences bordering infested areas are a source of infection, the larger a treated area is, the longer it will remain relatively free of ticks.

Stock must be kept off a treated area until at least 1 in of rain has fallen to allow maximum opportunity of contact between ticks and DDT.

Recommendations: Until further work is done with autumn applications of DDT superphosphate for the control of cattle tick it should be applied at 2½ to 3 cwt per acre in late winter or early spring whenever the small ticks are about in large numbers.

If precautions already mentioned are taken, good control of this pest should be obtained. In addition DDT treatment will give protection against grass grub for up to three years. Much of the area subject to cattle tick also suffers from grass grub damage.

(F. B. Muller. New Zealand Journal of Agriculture, Oct. 1960, *101*, (4).)

Effect of Thiram on Poultry: Wheat treated with the seed protectant thiram (tetramethyl thiuram disulphide) fed in trials to pullets in full lay at the Department of Agriculture's Poultry Demonstration Plant, Upper Hutt, caused a rapid and spectacular drop in egg production. The treated wheat comprised 78% of the ration and production dropped to 3% in three days, returning to almost normal in less than a fortnight after feeding of the thiram-dressed seed was stopped.

Controlled Feeding Test: Four pens of Australorp pullets were used with 30 birds to a pen. A mash grain diet was used, the mash being fed ad lib with a scratch feed of 1¾ oz of wheat per bird per day. Two pens were used as controls and two for measuring the effect of thiram-treated wheat.

Rations fed to both groups of birds were identical, with the exception that ground wheat used in the mash and also whole wheat fed as a scratch feed to two pens was thiram treated. The wheat used in the ration for both groups was 78% of the total food.

Results of the feeding trial are shown in the charts. While the production of the control birds continued to rise the egg production of the thiram-fed birds made a spectacular drop as follows:

	Production
First day	63%
Second day	28%
Third day	3%

Production remained at 5% or lower until treatment was stopped after 20 days. The thiram-fed group were then given the control ration and a rapid rise in egg production resulted. A 50% level of laying was reached in eight days and in 10 days the birds were close to the production level of the controls.

As a check a control pen was changed over to the thiram-treated wheat ration and an almost immediate and serious decline in production resulted as shown on the chart.

During the 20 days of the trial the thiram-fed birds averaged 3.63 oz per bird per day, which was 0.73 oz less than the average for the controls. It is reasonable to conclude that this was due to the reduced requirements of the treated birds, as they were laying so few eggs.

A feature during treatment and after was the health of the birds. They appeared normal healthy birds in full lay and visited the nests as usual, but without laying. There was no sign of moulting. One bird died during the test, but from a control pen. Eggs from the group under thiram treatment were abnormal, some being misshapen and others were severely wrinkled or corrugated.

Young chickens were tested in specially designed cage brooders. A ration containing 57% of thiram-treated wheat was fed to two cages of 25 chickens from five to 26 days old and the same number was kept as a control in two cages. There were no significant differences between the two groups in body weight, mortality, or food consumption. At the end of the test both groups were well feathered and appeared in good health.

(F. C. Bobby and J. Edmondson. New Zealand Journal of Agriculture, Nov. 1960, *101*, (5).)

NIGERIA

Agricultural Research

Maize, Stem Borer: An insecticidal trial against maize stem borers was carried out in collaboration with the Western Region Ministry of Agriculture and Natural Resources at Agege using aldrin, DDT, dieldrin, endrin and "Rogor". Data obtained from thinouts indicate a very low incidence of stem-borers throughout including the control plots. Later stand counts and dissections of dead and moribund stands likewise gave very low counts. In the stem count at harvest no significant differences appeared.

Cowpea Virus: Further studies of the virus diseases affecting cowpeas have revealed two distinct types; one is a strain of tobacco mosaic virus and the other, causing more severe symptoms, has been named cowpea yellow mosaic virus. Plans are now under way for devising measures for the control of these viruses in the field.

Cassava Red Mite: The trial with N.V.Philips-Roxane "Duphar-Tedion V18" against *Tetranychus telarius* (L) was completed. It was found that control was achieved within five days of spraying. Maximum control was recorded eight days after spraying, and control effects persisted for two months after spraying. It must be mentioned, however, that there was throughout the experiment a constant decline in the mite population on the controls so that the long-term control effects may be partly due to the fact that unfavourable conditions not connected with the application of "Duphar-Tedion" had begun to operate against mite. In such circumstances a population decimated by chemical control might tend not to recover even after the effect of the acaricide had ceased to operate.

Cassava, Mosaic Virus: Studies have been continued on the spread of the virus in the field in relation to the level of population of the white-fly vector. Attempts have been made to isolate possible strains from the cassava mosaic virus complex. However, no success has been achieved even with single insect transfers.

Citrus Tristeza: Trials at Ibadan of citrus rootstocks tolerant to the virus disease tristeza are now beginning to show results. Sour orange is a most susceptible stock for both acid lime and sweet orange, while Cleopatra mandarin and the grapefruit x mandarin hybrid (Lake Tangelo) appear to confer tolerance.

Yam Disease: A more detailed investigation of this problem is now in hand. During the last two months of the growing season, work was confined to field observations of the symptom picture of the disease.

Symptoms of the disease have been observed in *Dioscorea rotundata, D. cayenensis* and *D. alata*. The symptom expression is most marked in the two former species and takes the form of either vein clearing and interveinal chlorosis, severe chlorosis, and green islands, or a faint mottling of light and dark green. The leaves tend to be lanceolate, often distorted and curled.

During the past two years, all attempts at transmitting the disease by mechanical inoculations and the regrowth of tubers have failed. All methods of transmission are to be tested in an attempt to prove the viral nature of the disease.

Yam Beetle: Experiments on the control of yam beetles continue to indicate that seed dressing with insecticides is the most effective method, with aldrin and "Gammalin A" (containing gamma BHC) proving the best of the insecticides tested.

A 2.5% aldrin seed dressing was again the most successful at decreasing yam beetle attack and causing a corresponding yield increase. In four experiments, it decreased yam beetle damage by 19% (79% of the total attack rate on untreated plots) and increased yield by an average of 550 lb (8% of the yield on untreated plots). The rate of application on these plots averaged 27 lb (about 36/- at ¼d per lb). The minimum value of yams is 10/- per cwt so that even at these low attack rates it is still economical to use aldrin, even without considering the increased value of undamaged yams.

In six experiments "Gammalin A" seed dressing increased yield by an average of 750 lb per acre (10.4% of the yield on untreated plots) and decreased damage by 19% (79% of untreated attack rate). It thus appears better than aldrin, but in experiments in which the two were compared aldrin gave better control of beetle damage and a better overall yield increase, though it was not so convincing in the latter respect.

Five per cent chlordane and 2% dieldrin seed dressings decreased beetle attack and increased yield but were not so good as aldrin.

"Agrocide 7" was the most effective insecticide in controlling yam beetle damage, but in all three experiments in which it was tried treated plants gave lower yields than untreated ones.

An attempt was made to control yam beetle damage by applying "Gammalin A" into the planting holes before planting. The machine used was unfortunately defective and applied only about 10 lb per acre. It increased yield and decreased damage but "Gammalin A" seed dressing at 24 lb per acre was significantly better in both respects.

Aldrin, dieldrin and chlordane were applied to the planting holes from a knapsack sprayer. In general it may be said that at the concentrations used the insecticides caused some decreases in damage, but these decreases were not as marked as those caused by dressing the yam setts before planting. Aldrin proved the best of the three insecticides used in this way.

This method of control of yam beetles is to be further studied, although, unless it is distinctly better than the seed dressing method, it is unlikely to be adopted by farmers owing to the ease and convenience of seed dressing.

Insecticides were applied also on the surface of the hills but none of the sprays and dust used gave any appreciable control of yam beetle damage.

Four experiments were laid down in December 1958 in Delta Province to test the effect of dieldrin and other dusts used as seed dressings upon yield of yams and yam beetle attack. They are to be compared with other insecticidal treatments applied to the soil surface at the time of beetle flight.

Tobacco, Whitefly: Insecticidal trials against whitefly *Bemisia tabaci* (Genn.) were carried out on cassava at Moor Plantation and on tobacco at Ogbomosho, using the chlorinated hydrocarbons "Gammalin 20" (½ pint in 5 gallons of water), dieldrin (½ pint in 5 gallons of water) and the organo-phosphorus systemic insecticide "Rogor 40" or "Fostion" (1/10th pint in 5 gallons of water).

In the trial on cassava at the first sampling 22 days after spraying, the dieldrin and the "Rogor" treatments differed significantly from the controls at the 0.001 level but not from each other. At the second sampling 42 days after spraying, all three treatments were significantly different from the control at the 0.001 level and "Rogor 40" gave a significantly better control than "Gammalin 20" but not better than dieldrin. At the third sampling 66 days after treatment, only "Rogor 40" gave significant control at the 0.001 level.

In the third trial on tobacco at Ogbomosho all three treatments showed significant control at the 0.01 level at the first sampling 10 days after treatment. At the second sampling 31 days after treatment, only "Rogor 40" gave significant control at the 0.01 level. At the third sampling 63 days after treatment only "Rogor" gave significant control at the 0.01 level. "Rogor 40" therefore seemed to hold out considerable promise. But in a later trial also on tobacco at Ogbomosho using only "Rogor 40" (1/10 pint in 5 gallons) in one and two applications sprayed on the plants and at 0.1 per cent concentration applied at the rate of 100 ml. per plant to the soil round the base of the stem, results completely failed to confirm the efficacy of Rogor 40. It is suspected that the Rogor 40 used, which was of the same stock as that applied in the previous two trials, had meanwhile deteriorated.

Coffee Berry Borer: Insecticidal trials against the coffee berry borer, *Stephanoderes hampei* Ferr., were carried out in collaboration with Dr. F. Sands of the International Development Services Incorporated on the coffee plantation belonging to the Western Region Development Corporation at Isuoda, Owo, and on two private coffee farms at Ebute-Igboro. The insecticides used were different formulations of endrin, dieldrin and "Gammalin 20".

At Ebute-Igboro the trial on one farm yielded no significant differences. In the trial on the other farm there were no samplings. The first 84 days after spraying analysis showed that all treatments were significantly better than the controls at the 0.001 level and that endrin was better than dieldrin but not significantly better than "Gammalin". At the second sampling 98 days after treatment, all treatments differed significantly from the controls at the 0.001 level but not from each other.

The trial at Isuoda, Owo, was sampled twice - 57 days and 76 days after the first spraying. The first sampling showed that dieldrin in water, both one and two applications, and endrin in oil, in two applications were significantly better than the controls at the 0.01 level. The second sampling gave only dieldrin in water, in one application and dieldrin in oil, two applications, significantly better at this level. None of the treatments was significant at higher levels and there was no significant difference between the treatments.

Transmission of Viruses: It has been established that both viruses are transmitted by the Galerucid beetle *Ootheca mutabilis* Sahlb.. Laboratory studies have confirmed that cowpea yellow mosaic virus is probably carried only on the mouth parts of the beetle. Infection passes off rapidly (within 48 hours) when the vectors are serially transferred on healthy seedlings. In field experiments carried out in collaboration with the Senior Botanist of the Western Region Ministry of Agriculture and Natural Resources, it has been shown that seed treatment with "Thimet" (a systemic insecticide seed dressing) in no way affects the population of the beetles in the crop or the spread of the virus, and that close spacing of plants (6 inches on 2-foot ridges) results in significantly less infection than wide spacing (2 feet on 4-foot ridges).

Miscellaneous: The coffee trunk borer, *Bixadus (Monohamus) sierricola* White was recorded doing severe damage to coffee trees in the Cameroons. Surprisingly, this beetle has not previously been recorded from Nigeria although it is widely distributed in the Guinean belt extending from French Guinea to Uganda. From reports it appears that quite young trees of three or four years were being attacked and many killed. The life-history of this beetle is well known. Unfortunately it nearly all takes place inside the tree trunk so that control measures can be effectively applied only during the brief space between the laying of the egg and the penetration of the tissue by the young larva. The adult is very short-lived and eggs are deposited in crevices in the bark as soon as it emerges from the pupa.

A severe outbreak of *Ootheca mutabalis* Sahl occurred on cowpeas during June and was effectively suppressed by an application of Gammalin 20.

During a visit to the Eastern Region Development Corporation's cashew plantation at Enugu very severe damage due to *Helopeltis sanguineus* Popp. was observed.

The potato tuber moth, *Phthorimaea operculella* Zell. was bred out from imported potatoes on sale in Lagos.

A new species of yam beetle has been found during the year bringing the number of species of Dynastid beetles attacking yams in Nigeria up to four.

Applications of insecticide to guineacorn and millet have, on the whole, shown little promise of controlling *B. fusca* and *C. ignefusalis* and have been temporarily suspended while stem-borer biology is further investigated.

(Annual Report of the Department of Agricultural Research 1958/59. Lagos, 1960.)

NIGERIA - NORTHERN

Tsetse Control: Tsetse fly eradication by clearing has become increasingly difficult during recent years, due to the increased cost of labour and the difficulty of obtaining sufficient labour in rural areas to carry out the clearing programmes. This has been one of the factors which has led to the investigation of the practicability of riverine tsetse eradication by the use of insecticides in conjunction with present clearing methods, which include mechanical aids whenever these are practical and economic.

Preliminary insecticide trials against *Glossina tachinoides* have been carried out in Kano Province in mango groves, using DDT. These small trials were most promising. Therefore, during 1955 a trial on a larger scale was started near Gboko in Tiv Division. This attempted to eradicate *G. palpalis* along a river with patches of very thick vegetation. Four applications of 2½% suspension of DDT in water were used and the follow-up in 1956 demonstrated that although eradication was not achieved, a very considerable reduction in the fly population resulted. It is believed that failure to eliminate the fly completely was due to insufficient isolation of the site by clearing and by the "crossover" of flies from another system.

Simulium Control: A Simulium Control Unit was established in Abuja in May, 1955, consisting of an Entomologist and some M.F.U. Assistants.

Early in 1956 preliminary work started on the construction of roads to larviciding points on the Iku, Tapa and Usuman rivers and supplies of DDT, and diesoline assembled. The larviciding operation itself started on March 5th and continued for twelve weeks. At each "dosing" operation, carried out at four points on the same day each week, the river flow was measured using a current meter and that dosage of 10% DDT in diesel oil calculated which would give a concentration of one part per million. The dosage was carried out by primitive means applicable to remote areas difficult of assess and the insecticide solution was delivered from four gallon kerosene tins suspended over the stream and punctured to a standard single aperture which ensured delivering over a period of twenty minutes.

Initial results were dramatic. In the Abuja control area there was a 96% reduction in the Simulium fly population and in Abuja town itself the reduction was 98%, compared to the fly surveys carried out over the same period in 1955. The breeding in the rivers treated was almost entirely eliminated over a distance varying from twelve to fifteen miles. The pattern of distribution of the 4% of flies surviving was directly related to the breeding sites where the effect of the insecticide had not been absolute. The survival of these flies gave rise to considerable re-infestation of the control areas as measured by pupal surveys carried out in the early dry season - November - when conditions permitted the carrying out of these surveys.

Using similar equipment to that used at Abuja larviciding of the Kaduna River started in the middle of April and ten treatments at intervals of five days were given. The period of treatment had to be shortened owing to the sudden increase in the river flow due to unexpectedly heavy and early rains.

Control was not so effective as at Abuja and only an 80% reduction was achieved over the period August to November. The height of the stream immediately after treatment prevented reliable pupal surveys but in those areas accessible there had been apparently complete initial elimination for a distance of twelve miles down stream from the dosing point. The pattern of distribution of the 20% of flies caught later suggested that breeding had not been completely eliminated, particularly as there was no evidence of simulium breeding found in the small tributary streams joining the main river in the control area.

Experimental clearing of the grass on the banks of the Kaduna river and within the control area was also carried out as it was believed that the vegetation on the banks might offer suitable holds for the immature larval stages arising from surviving flies.

Snail Control: From the Argungu Rural Health Centre investigations into the efficacy of sodium pentachlorophenate as a molluscicide under village conditions are continuing. Gwandu village has been chosen for this work and the ponds and borrow pits in and around the village will be treated under the supervision of the Health Centre staff.

Work at the Wulgo Irrigation Scheme has had to be suspended throughout the period under review, owing to the unusually high and sustained water level in lake Chad.

Cyclops Control: Experimental work carried out to determine the effect of insecticides in the intermediate cyclops host showed that whereas DDT, in a concentration of 1:100,000 in well water had little effect, "Gammexane" in a 1:5,000,000 solution of gamma isomer gave a 100% kill within one hour. Dieldrin gave similar results but is too toxic for use in drinking water. Another experimental approach was to use dyes to stain the water of infected burrow pits as a deterrent to its use. The colours, of brilliant green or crystal violet, fade within two days and it seems unlikely that such a measure could be of any practical use.

(Annual Report of the Ministry of Health for the Year 1955-56.)

Agricultural Pest Control

Citrus: Observations were made on the relationship between ants and the soft scale of citrus *Coccus hesperidium L.* The most common ant in the association at Samaru is the arboreal *Oecophylla longinoda*, Latar., which lives in colonies extending over as many as twenty-five trees, each tree containing up to fifty nests.

All the nests examined contained the scale and the degree of parasitism on scales inside the nests was considerably lower than that outside. The numbers of scales within a nest could be reduced by preventing the access of ants to that nest. There was some suggestion that the ants assisted in the spread of the scales.

A foliage spray of 1.5% dieldrin kept trees completely free of ants and scales for sixteen weeks. This spray was superior to 4% DDT or 1% gamma BHC. Neither 1.5%

dieldrin or 4% DDT were successful when used as a trunk spray against *Oecophylla*, but the former insecticide was effective in keeping seedlings free of scales tended by a ground-living ant *Crematogaster;* sp.

Observations were also made on *Papilio demodocus* Esp. the defoliating larva of which can be controlled by hand-picking, and on *Argyroploce leucotreta*, Meyr., which causes fruit-fall, and which can be controlled to some extent by orchard sanitation.

Cotton: Insecticide trials on cotton at Mokwa were continued to extend the results obtained there last season. The results obtained indicate that six weekly application of a spray mixture containing DDT (at 1 lb per acre) and gamma BHC (at 0.3 lb per acre) during late September and early October would give adequate control of the primary invasion of cotton stainers, and would reduce bollworm damage. Highest yields, at a little under 1,000 lbs seed cotton per acre, were less than those of last year; nevertheless it is clear that further field scale experiments on the economic possibilities of insecticide control at Mokwa are desirable.

Encouraging results were also obtained at Shendam using a DDT/BHC spray to control cotton stainers. Smaller increases in yield were recorded at Gombe and Kontagora, where insecticidal dust was used on cotton. At other stations in the Riverain area results of insecticide trials were disappointing.

Groundnuts: Results from a trial at Samaru for two seasons show that fungicidal spraying can control *Cercospora* leaf spot of groundnuts. This considerably increased the yield of the introduced varieties in the trial but had little effect on the locally bred varieties which appear to be tolerant of the disease.

Seed dressing trials have shown that Fernasan D, which is successful with millet and guineacorn, is by no means the best for groundnuts. The breakdown products of gamma BHC appear to be toxic to the young plants. Investigations continue to find a dressing which will be applicable to a wide range of crops.

Stored Produce

A. **General:** With the exception of the Bornu Area where BHC is still being used, malathion has been generally introduced. Points in its favour: it is more persistent than BHC and it will control *Trogoderma granarium* as well as *Triboleum castaneum* (principal pest infesting groundnuts). Specially adapted Lister orchard sprayers (SS2 and SS4) are used for the main routine spraying, with a 25% w.p. formulation. A new technique, also, is reported of dusting under sisalkraft paper with a 'Motoblo' dusting machine using 4% malathion dusting powder.

During the period of intensive night flight by *Tribolium*, 5/50 Pybuthrin, as a knockdown spray, was applied from Todd Insecticide Fog Applicators. Operations were started about one month before 'coverage' date and ceased when all pyramids had been covered with tarpaulins. Motoblo Mistblowers were found useful for the dispensation of insecticide dusts.

Guineacorn: stored in rumbus, both on the head and after threshing, and treated with an insecticidal powder containing 0.5% gamma BHC, showed a marked reduction in insect damage compared with untreated grain stored under similar conditions.

The dust was applied at the rate of 1 oz and 5 oz per square yard of cross-sectional area of the rumbu, and the gamma BHC content of the grain was determined at the time of treatment and after nine month's storage. Even at the higher dosage rate, the concentration of gamma BHC had fallen to 1.4 ppm, the maximum permissible concentration on grain prepared for food being 2.5 ppm.

Smut Disease Control: Experimental work has shown that "Fernasan D" is more effective than copper carbonate as a seed dressing and has the advantage of being an insecticide as well as a fungicide. Sale of "Fernasan D" is now being arranged through commercial channels. Fertiliser and seed dressing has been coupled with the popular Kano "K.50" groundnut seed multiplication scheme by issuing a £1 pack of seed, fertiliser and Fernasan D.

Locust: Swarms were reported from Bornu, Bauchi, Sokoto, Kano and Katsina, but no egg laying was observed or damage caused.

Quelea: in Bornu, caused widespread damage on millet and Masaka guinea corn, estimated at 20,000 tons of grain lost and resulting in an increase in cereal prices. Nesting and roosting habits of this bird were observed, with a view to a campaign against it in the coming year. From the study already carried out on this subject it appears that the Quelea problem in Bornu is of a different magnitude from that experienced in other countries which have this pest. The inaccessibility of the nesting and rooting sites in the vicinity of Lake Chad poses problems of the utmost difficulty, particularly when the sites are in the reeds on the fringe of the lake.

(Annual Report of the Ministry of Agriculture, 1957 - 1958.)

WEST AFRICA

Cocoa Pest Research

Shot-Hole Borers: Two experiments involving the application to cocoa seedlings of a urea-formaldehyde lacquer incorporating 10% dieldrin and 4% aldrin when dry and of aqueous emulsions containing 0.5% dieldrin have been carried out at Moor Plantation, Ibadan and at the Agricultural School Farm, at Akure to investigate the effectiveness of these products in controlling 'shot-hole' borers (Scolytidae).

In preliminary laboratory tests for phytotoxicity it was found that the urea-formaldehyde lacquers caused scorching and blackening of green stems. The damage was only superficial except on very young developing flushes, which were killed. Hardened stems were not obviously affected. For this reason the lacquer was applied only to the lower 12 in. of the plants. Applications were made with a brush in October before the seedlings were planted out at Ibadan, and to plants already growing in the field at Akure. The emulsion was spread on to the stems at monthly intervals beginning in November.

It was observed that fewer stems were attacked in the plots treated with the urea-formaldehyde lacquer than in the other plots, both at Ibadan and Akure, during the first two months but the degree of control obtained was unsatisfactory (33%) and was not maintained during the remaining three months during which observations were made on these plots.

At Akure the attack was slightly lower on the watered plots than on the unwatered ones, but the most significant results of this treatment was found to be the great reduction in the number of seedlings dying or suffering from severe wilt (2.5% of the watered seedlings and about 70% of the unwatered ones). Many of the earlier entry holes, particularly in the watered plants, had closed by the time that recording ceased in March and the secondary borers (mainly *Stephanoderes* spp.) which attacked the wilted and dead stems, were absent from those in which growth had continued, even though as many as four or five primary *Xyleborus* entry holes had been made in some of the latter.

Capsid Control with Gamma BHC in Kerosene: The method and cost of spraying large areas of cocoa using power driven knapsack mist blowers is fully discussed by Hammond (Rep. Cocoa Conf., London, 1957). The overall cost per acre of this method is high and it seems important to reduce this cost while maintaining the efficiency of the operation. C. S. Wishart, Plant Protection Ltd. (unpublished information 1958), suggested that a volatile solvent would offer many advantages over water as a carrier, and trials were carried out to determine the phytotoxicity of such a spray mixture, to determine the effective spray swath width compared with that of the normal water spray, and to find the area of cocoa covered by a measured quantity of the kerosene spray mixture using this swath width. In all the trials the spray was applied at the rate of 1 pint of 'Gammalin 20' in 1 gallon of kerosene, using a 'Motoblo' machine with a size 00 jet.

Using a 16-yard swath with this quality of insecticide in one acre of cocoa, satisfactory results were obtained. The lateral dispersal of the spray, greater than that of a water spray, was at least 20 yards at maximum width. The upward movement of the spray into the canopy was as great as that of the water spray. At this rate of application there is no danger of phytotoxicity. The kerosene spray causes slight irritation to the eyes, nose and throat, and for this reason care is necessary in its use. If it is possible in future work to use a cheaper volatile solvent and a smaller jet, this further reduction in cost, quantity applied per acre, and general transport and labour costs might make this a practical proposition for large-scale spraying of cocoa against capsid.

(West African Cocoa Research Institute. Annual Report 1958-59.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

ANTIGUA

Cotton: The 1956/1957 cotton crop was a disappointment to cotton growers throughout the island. This was a direct result of an unusually dry planting season coupled with the high incidence and excessive damage caused by cotton leaf worm *Alabama argillacea* and pink boll worm, *Platyedra gossypiella.*

The area from which harvesting was done was 3,275 acres as compared with 5,240 acres in the previous season. Extremely adverse weather conditions led to patchy germination which in its turn led to the abandonment of many areas planted with cotton.

The year's cotton production was as follows

	Acreage	Clean Lint	Stained Lint	Total
	lb	lb	lb	lb
M.S.I.	2,500	342,878	29,330	372,208
V.H.8.	775	133,651	19,689	153,330
Total	3,275	476,529	49,019	525,538

The overall yield of clean lint per acre was 145.5 lb - as compared with 190 lb per acre and 241.9 lb per acre for years 1956 and 1955 respectively.

The 1957/1958 crop got off to a very good start with exceptionally good weather conditions. The incidence of cotton leaf worm (*Alabama argillacea*) and pink boll worm (*Platyedra gossypiella*) was reasonably low but the green stink bug (*Nezara sp.*) caused much damage to cropping in areas where timely measures were not practised.

An attempt was made to control pink boll worm in the field by repeated sprayings with DDT. Although some reduction in the pink boll worm population was noted nothing approaching economic control was attained. A survey of pest damage in the general crop made in January showed an average of 24% bolls damaged by sucking bugs in peasant areas and 17% in estate areas. Control of this pest was readily achieved by toxaphene on all station trials.

Trials were laid down with seed dressings against bacterial disease but in contrast to last season the incidence of this disease was too low to enable an assessment of the efficiency of the dressings to be made.

Arrowroot: Arrowroot is subjected to damage by a number of lepidopterous larvae which can reach serious proportions if control measures are not adopted. During October - November heavy infestations of the arrowroot leaf roller (*Calpodes ethlias* Cramer) and *Prodenia* sp. were experienced. These were controlled quite effectively by the use of toxaphene.

Castor: Quite a wide range of insects pests were observed to attack castor which included the green stink bug, *Nezara* sp., corn earworm, *Heliothis sp.* and *Prodenia sp.* Insect damage was reduced by the use of toxaphene.

(Annual Report of the Agricultural Department for the Year 1957.)

BECHUANALAND

Veterinary Pest Control:

Dips: Apart from the spraying of cattle which the department carried out at its various quarantine camps, and apart from the facilities provided at the majority of the line of rail stations, little direct interference by the department in the control of tick parasites takes place. Reports, however, indicate an increasing awareness on the part of both the African and the European of the dangers of gross tick infestation of their stock and a number of the more progressive farmers and traders have established dipping tanks or spray races. Departmental propaganda, by both word of mouth and demonstration, continued during the year, albeit at a reduced rate. The propaganda was directed at encouraging the African to purchase spray pumps, either of the stirrup pump type, or of the more expensive, but more effective, double action "Spray Well" pump, and encouraging the African to purchase dipping materials which are sold by the department at a highly competitive figure. Dipping tanks at line of rail stations were emptied during the year and refilled with toxaphene dips which unlike the benzene hexachloride and D.D.T. dips are readily subjected to test to determine the concentration of the active principle.

Trypanosomiasis: This disease is enzootic in Ngamiland and on the Chobe. In Ngamiland, *G. morsitans* finds its natural habitat in the swamps which are about 7,000 square miles in extent and from which the fly is steadily encroaching on grazing grounds. Large numbers of cattle have retreated leading to gross over-stocking of areas away from the fly, with consequent denudation of the veld. The encroachment of the fly has been largely in a westerly direction in the vicinity of Tsau and Nokaneng where it has advanced on a broad salient on the western bank of the Taoghe River. It is unlikely that the fly will extend much further to the west in this area since the vegetation is unsuitable for permanent habitat. The indications are, however, that extension could take place from the base of the salient to the north and south along the western margin of the swamps. To the south advance has occurred in the direction of Lake Ngami, particularly in the area of Makakun. On the eastern side the fly has advanced towards the Chobe River in the region of Kavimba and an increasing number of cases of trypanosomiasis and deaths from trypanosomiasis are reported annually from this part of the Protectorate. In both areas the position is confused by the widespread occurrence of helminthiasis, particularly fascioliasis, which complicates the clinical picture. The two diseases have been difficult to differentiate in the past due largely to the absence in Ngamiland of sufficient trained staff. Control of the disease in Ngamiland itself, except for an odd case brought to departmental personnel either at Maun or in the course of their tours of the district, is largely left in the hands of various cattle traders who purchase and use large quantities of trypanocidal drugs every year. In order to prevent the spread of infection out of Ngamiland to areas which are unsuitable for tsetse, but in which infection could be transmitted by mechanical means, the Veterinary Department treated all cattle passing through the quarantine camps at Makalamabedi and Kuki with trypanocidal drugs. It is considered that the mortality of 489 head of cattle reported from the enzootic areas does not represent more than a fraction of the total mortality which occurs annually from trypanosomiasis.

(Annual Report of the Department of Veterinary Services for the Year ended
31st December, 1957.)

BERMUDA

Pest Control: Climatic and other conditions in Bermuda unfortunately favour the propagation of many insect pests, which constitute a perennial problem for the Department. The Mediterranean fruit fly has long been a major pest in the colony and has made the growing of peaches virtually impossible. Latterly it has become an increasing menace to the recently developed and otherwise flourishing local citrus industry. After gathering information early in 1957 on the methods successfully employed to deal with this pest in Florida, the Department embarked on an intensive campaign of experiment, investigation and the use of baits, sprays and traps to control the fly in Bermuda. Thorough use of trapping with carefully timed bait sprays during the critical summer months appeared to provide a solution of the problem because no significant damage was recorded in any of the orchards which were sprayed regularly from the beginning of May.

The two large mechanical sprayers operated by the Department were fully employed responding to the requests of farmers and citrus growers, during 1957 and 1958, 150,000 and 202,112 imperial gallons respectively of spray were applied to citrus, farm crops and ornamental plants.

Disinsectisation: In 1957, 3,262, and in 1958 4,068 aircraft arrived and were met by the Health Inspector who, as soon as their passengers disembarked, closed the aircraft and carried out disinsectisation followed by a thorough inspection and count of the various insects found aboard. The Health Inspector inspects daily the Airport and surroundings, including the disposal plant, all rest rooms, the catering department, kitchen and restaurant.

In 1957, 341, and 1958, 335 arriving vessels were met and examined for rats and insects, and for the validity of deratting certificates and passengers' vaccination certificates.

(Bermuda, Report for the Years 1957 and 1958. H.M.S.O. London 1960.)

BRITISH HONDURAS

Forestry

Mahogany Shoot-Borer: Experiments are in progress to control mahogany shoot-borer, *Hypsipilla grandella*, using the OP systemic insecticides, "Pertox" and "Metasystox". The method of application being tried is that of absorption through the bark.

(Annual Report of the Forest Department for the Year 1959.)

Malaria Control: The malaria eradication programme continues. This service has been reorganised and a Medical Officer has been appointed full-time director of the programme to raise the efficiency of the service to the standard required by the World Health Organisation. Two spray-cycles were completed in which 25,713 houses were sprayed with DDT, 5% and dieldrin, 1.5%.

A team of malaria investigators of the World Health Organisation conducted a country-wide malaria survey of the school-age population, 8,000 blood samples were taken, of which 18 had malaria parasites. The local evaluation services collected 1,910 blood samples from febrile cases of which 253 were confirmed as malaria. In keeping with the eradication programme smears were taken from contacts of confirmed cases and their houses were sprayed.

(British Honduras, Report for the year 1958. H.M.S.O. London 1960.)

BRITISH SOLOMON ISLANDS

Agriculture

Coconut: Research has continued into the problem of early nutfall, caused by the Coreid bug, *Amblypelta cocophaga* but no economic control is yet in sight. The Asian Rhinoceros bettle, *Oryctes rhinoceros*, continues to be a threat to the industry but so far has not been introduced from neighbouring territories.

Cocoa: *Amblypelta cocophaga*, which causes premature nutfall on coconuts, is also responsible for some damage on cocoa both to the young shoots and to the developing pods. Some serious damage has been done in places by the weevil, *Pantorhytes biplagiatus* which bores into young trees, usually at the jorquette, causing mechanical damage or death. Grease banding experiments have been undertaken. Other pests and diseases have been recorded but the extent of their damage does not so far appear to be serious.

Public Health:

Malaria: Medical control continues by routine spraying and clearing of bush, but this disease still remains the most widespread in the Protectorate. The W.H.O. Malaria Adviser visited the Protectorate in 1957, and has submitted a scheme for the eradication of malaria. No decision has yet been taken on the matter owing to the very high cost and the limited financial resources of the Protectorate.

The eradication programme carried out during 1954 at Ontong Java has not proved to be as successful as was hoped. A further campaign is, therefore, planned for 1959, in collaboration with Messrs Imperial Chemical Industries (Pharmaceuticals) Ltd., who have provided generous supplies of Lapaquin. Domestic spraying with dieldrin plus chemotherapy with the I.C.I. drug are the two synchronous methods to be adopted, in contrast with the larvicidal attack which so nearly achieved success in the same islands group in 1954.

Malaria proved to be troublesome among the recently arrived Gilbertese settlers at Titiana, Western Solomons, but was under effective control at the end of 1958 by virtue of larvicidal measures, prophylactic chemotherapy and the issue of mosquito nets.

(British Solomon Islands Report for the Years 1957 and 1958.)

CAMEROONS

Banana

Pest and Disease Control: Control measures against "Cigar End" disease (*Trachysphaera fructigena*) had to be continued, but owing to the small quantities of fruit shooting during the period of heaviest infection, deflowering cycles were easily maintained, even though on the higher altitudes a two-day cycle was necessary.

Infestation by the banana borer (*Cosmopolites sordidus*) continued and control measures could only be applied to a proportion of the plantations owing to the late arrival of the insecticide.

The presence of eel-worms, particularly the burrowing nematode (*Radopholus similis*) had been established throughout all the banana plantations and is causing concern in connection with the alternative varieties of planting material, as the majority of these Panama Disease resistant clones would appear to be susceptible to attack by this pest. Experiments are being carried out with a soil fumigant, but this method is very expensive.

Control of Sigatoka leaf spot was again maintained using ground machines and fixed wing aircraft. The disease has been more difficult to control due principally to the period of very rapid growth which followed the windstorm, and there would appear to be a change over from the *conidiospore* type of infection to one which is now predominantly *ascospore*. The infection from unsprayed small holdings ajacent to the plantations is also a contributory factor to the spread of this disease. The relation between various spray mixtures and their effect on the fruit and bunch weight, and also their phytotoxic qualities, has been examined.

Cocoa

Black Pod: The spraying programme against black pod started in February and finished in October. The incidence of this disease was lower on the plantation than expected, despite heavy infection in nearby native areas indicating a bad season for the disease.

Oil palms

The disease reported in 1958 has been confirmed as vascular wilt and is beginning to spread rapidly. The selection from high yielding Deli Dura palms for resistance to this disease has commenced, together with yield recordings.

Rubber

The disease resembling powdery mildew observed in Tj.16 has been confirmed as *Oidium heveae*.

Pepper

A root disease which has occurred previously became more prevalent after the rainy season and is under investigation.

(Cameroons Development Corporation. Annual Report for the Year 1959.)

DOMINICA

Biological Control: The Colonial Development and Welfare Scheme for the biological control of locally imported insect pests continued.

The chief activity under the scheme comprised introductions of two banana borer predators *Lieonota* and *Plaesius* from Trinidad, to ensure a more rapid build up in the population of the predators and consequent control of the banana borer.

During the year 4,733 predators were introduced as adult insects and liberated in banana fields known to be highly infected with borer

Rodent Control: A small anti-rat campaign continued. Operations essentially comprised the free distribution of warfarin to farmers and to householders.

(Annual Report of the Department of Agriculture and Forestry, 1958.)

EAST AFRICA

Tea

Red Mite: The current recommendation for tea not in plucking is to spray with "Rogor" or "Metasystox" at the dilution of one fluid ounce to five gallons of water.

Borers: Borers reported as attacking tea seed bearers on an estate at Kapsabet were identified by the Scott Laboratories as *Apote monacha* Fab., commonly known as black borer of coffee. It is known to attack wattle, *Grevillea robusta*, citrus, etc., but this appears to be the first record on tea.

The adult bores into the host, making a circular tunnel, and depositing behind it a certain amount of frass, resembling sawdust. The control measure recommended is the injection of a saturated solution of p-dichlorobenzene in kerosene into the galleries, and sealing them with wet clay. It is not likely that the borer will assume the status of a serious pest.

(Tea Research Institute of East Africa - Annual Report for the Year 1959.)

Research

Schistosomiasis: It was recommended at a previous Council meeting that research team from East Africa should be set up at Mwanza to investigate the various aspects of this disease. The team will be composed of Dr. P. Jordan, an epidemiologist, Dr. Webbe, an entomologist, to be seconded for this work by the Tanganyika Medical Department and Mr. McClelland, a malacologist, who has been working at Mwanza for some years under the aegis of the Colonial Medical Research Committee. Professor L.C. Beadle of Makerere College will act as Advisor to the team. The team started work during the second half of 1959, financed by a grant from Colonial Development and Welfare funds and by the three East African Governments. The team works in close liason with the Department of Zoology at Makerere College, Kampala.

Malaria and Vector-borne Diseases: Chemical investigations included the establishment of a method of urine analysis, to assist in measuring the base line of exposure to dieldrin, among the spraying personnel in the Paré Scheme. Dieldrin is an insecticide widely used in public health work and, in view of its known toxicity, studies of this type are of fundamental importance.

Attention has also been directed to the problem of snail and mosquito breeding in dams. The Malaria Engineer visited Uganda during the year, and with the active co-operation of the irrigation and health authorities of the Territory, several dams in Ankole were surveyed. At that time a provisional choice was made of the site for experimental control of disease vectors by the introduction of modifications in dam construction and maintenance. These measures will, it is believed, greatly reduce the health hazards that water impoundments are so liable to create.

Locust Control: Three Desert Locust Survey Beaver aircraft fitted with spray gear operated off Hargeisa and other airfields in the Somaliland Protectorate against the invading Arabian-bred swarms which contributed to the parents of the later short rains generation. During this operation 9,365 gallons of insecticide were applied to 150-200 square miles of low-density swarms, with evidently very good kills. As a result of this operation, only a small proportion of this lot of locusts were able to contribute to the subsequent breeding.

To supplement these aerial spraying operations, a Desert Locust Survey Officer was based near the Sheikh pass, which is frequently used by swarms during their passage eastwards across the Protectorate. Between 6th-24th July eight swarms were contacted and sprayed by ground teams using chiefly a single Dodge-mounted Micron sprayer set to emit about 2 gallons of B.H.C. concentrate per minute.

Examination of some of the roosting sites 6-22 days after spraying provided estimates of the minimum kill obtained. A total of 1,130 gallons of insecticide concentrate was sprayed on to over 30 square miles of infested country and a kill estimated at 645 million locusts obtained. This presents about 4 square miles of dense swarm.

The Danakil-bred swarms moved to the Giggiga plains and adjacent parts of the Protectorate during late September and early October were attacked by two Desert Locust Survey Beaver aircraft which sprayed over 20,000 gallons insecticide in about 200 sorties on to an estimated 250 square miles of high-density swarms. Impressive kills were obtained and serious crop damage in these areas averted. However, the invasion continued beyond the operational endurance of the aircraft unit, which was obliged to leave unmolested the major lot of parents of short-rains breeding which entered the area from late October to the end of November. The aircraft withdrew to Nairobi to re-equip in preparation for a December invasion of the East African Highlands.

Hoppers: With the help of the Colonial Insecticide Research Unit at Arusha, further studies were made of the pick-up of spray by targets simulating settled adult locusts. From these results it was possible to calculate the width of swathes containing various doses of insecticides, when spray is applied under different wind speeds.

(Annual Report of the East Africa High Commission for 1959. London: H.M.S.O. 1960.)

FIJI

Coconut: The campaign against the coconut rhinoceros beetle, *Oryctes rhinoceros* L., continued throughout the year. Total expenditure since the campaign began in 1953 reached approximately £370,000. The pest is gradually spreading and increasing in numbers on the island of Viti Levu, but has not yet invaded the copra-producing islands. Since January the campaign was restricted in scope, due to shortage of funds associated with reduced yields. Since then, only those areas where beetle populations are highest, and where the threat to the copra-producing islands is most grave, were treated. The number of palm-crowns treated with a mixture of BHC. and sawdust was 455,000.

The first trial in Fiji of air-spraying of a crop to control an insect pest was conducted during May, when the Department of Agriculture provided advice and finance for treatment of 100 acres of coconut palms infested by coconut stick insect, *Graeffea crouani*. A Tiger Moth aircraft, fitted with spraying apparatus, was used, the spray fluid consisted of a mixture of a solution of BHC. and diesoline. A kill of between 95% and 100% was obtained by applying 2¼ gallons of spray fluid, containing 4½ ounces of the gamma isomer BHC. per acre. Costs were moderate, and it is clear that air-spraying constitutes a practical solution to the problem of applying insecticides to tall palms in windy areas.

The parasite *Scolia ruficornis* is still being bred and distributed, as also are *Nematodes* of the genus *Rhabditis*. A grub infested by introduced *Nematodes* has been found in the field. Towards the end of the year Dr. Paul Surany, of the South Pacific Commission staff, made a short survey of diseases affecting *O. rhinoceros* in Fiji.

Rice: The year 1959 will be remembered among rice farmers for the unprecedented outbreak of rice yellows caused by leafhopper, *Sogata furcifera*. This was the first outbreak since 1953, and was an unpleasant surprise, as the leafhopper was thought to have been brought under permanent control by egg sucking *Mirid* bugs, chiefly *Cyrtorhinus lividipennis*. There were several unusual features, including the extended duration of attack, the severe damage done to "dry" as well as "wet" rice and the speed and completeness with which fields of rice were killed.

Owing to the general lack among growers of insecticide applicators coupled with the speed and completeness with which fields of rice were destroyed, the epidemic wiped out many plots completely and severely damaged others. In the Northern Division it is probable that the average yield did not exceed 5 cwt. per acre. Some 7,795 acres were planted in Vanua Levu and it is estimated that nearly half this acreage was completely destroyed. Families dependent on the rice crop lost their means of livelihood and it is feared that there will be a number of cases of hardship in the rice growing areas in early 1960. An emergency seed supply was organised and ten tons of seed purchased in Western Viti Levu were distributed by the field staff, with the assistance of local leaders, to needy farmers. The number of sprayers for hire in the non-sugar growing areas in the west of Vanua Levu (in those localities where sugar is the main crop it is felt that farmers should be able to purchase their own sprayers and insecticide) were substantially increased so as to be prepared for outbreaks in 1960.

Banana: New methods of scab moth (*Nacoleia octasema*) control have been tried out which require attention only three times a week. Best results have been obtained by two sprayings on alternate days with 50% DDT wettable powder followed by a dusting with 2% DDT spraying only, using three to four sprayings on alternate days, does not give quite such good control. Both methods however have produced better results than the traditional dusting which requires checking the plantation daily, thus demanding twice as much time as the new methods. Spraying is only to be recommended to the more progressive growers to whom time means money, as a bigger capital outlay is necessary.

In April Mr. R.W. Paine began a second tour of duty to investigate biological control of the banana scab moth, *Nacoleia octasema*. During the year he visited Malaya, Sumatra, Java, the Celebes, the Moluccas, and the chain of islands extending from Java to Timor. His investigations so far show that parasites which attack the scab moth on *Nipa* and *Pandanus* do not attack it on banana plants. Hence it is clear that a parasite which frequents the banana is required if we are to have any prospects of successful control of the pest. Mr. Paine has found such a parasite in Timor and Flores. The first consignment of these will reach Fiji in January, 1960. Mr. Paine has also found in Java a parasite which may be useful against the small coconut leaf moth, *Agonoxena argaula*. This will be sent to Fiji early next year.

The use of low volume oil spraying methods for leaf spot control is beginning to take on and a number of growers have purchased machinery to carry this out. Several oils have been tested during the year with the aim of selecting the least phytotoxic oil available. Low volume oil spraying offers a much more practical solution to the control of banana leaf spot disease than does the conventional high volume methods using copper or other organic fungicides.

Miscellaneous: The seedfly, *Tetraeuaresta obscuriventris*, which breeds in the developing seeds of tobacco weed, *Elephantopus mollis*, is well established throughout the island of Viti Levu. The fly occurs in vast numbers, and may well ultimately have a controlling effect on its host-plant. This insect was introduced from Trinidad in 1957.

The moth *Syngamia haemorrhoidalis* was introduced from Hawaii in 1958 and again in 1959 for breeding and liberation as a possible control of *Lantana*. This insect has now been recovered in the field in the Suva-Nausori area and can be considered to be established here. In Hawaii it has caused extensive defoliation of *Lantana*.

(Department of Agriculture, Annual Report for the year 1959.)

KENYA

Coffee

Leaf Skeletonizer: The leaf skeletonizer is the caterpillar of the moth *Leucoplema (=Epiplema) dohertyi* Warr. Family Epiplemidae). It was noted as a minor coffee pest in Uganda as long ago as 1928. In 1932 came the first Kenya record. Notley collected some specimens during an outbreak in Sotik.

Until recent years it was believed to be confined to the West Rift coffee but in 1956 there were widespread and severe attacks throughout the main East Rift areas. These attacks have continued sporadically in all districts but are usually worst on nursery seedlings and on coffee planted at the lower altitudes.

The author describes its life history from egg to adult. Eggs are laid, and the larvae feed, on the underside of the leaves. A single caterpillar can destroy about one-quarter of the leaf area of an average leaf. A day before the larvae is due to pupate, the caterpillar starts to turn red. The next day, usually in the evening, it lowers itself to the ground on a silken thread and burrows just below the surface. After approximately 10 to 12 days in the field, the adult moth emerges. It is grey and brown and has a wing span of about half an inch.

Among its natural enemies are a minute wasp, *Trichogramma* sp. which parasitize the egg: and *Euplectrus singularis* Ferr and a shield bug, *Macrorhaphis acuta* Dall., which attack the caterpillar.

Control: Almost any insecticide can be used to kill the caterpillars. Lead arsenate, pyrethrum, DDT, malathion and parathion have all proved adequate at different times.

Lead arsenate is recommended as the standard measure for use on plantations. It is a stomach poison, and therefore, only kills the caterpillars. Malathion or pyrethrum are useful alternatives for use at picking time when a non-poisonous insecticide is desirable. These will kill both caterpillars and moths.

DDT is not to be generally recommended except for spot-spraying a small area. Used indiscriminately, it is liable to precipitate attacks of other pests.

(T.J. Crowe. Kenya Coffee, July 1960, *25*, (295), 256-7.)

Pyrethrum

Insect pests: Thrips have been responsible for heavy losses during the year, whilst red spider mite has continued to cause damage even where sprays of persistent contact insecticides have been used. Experiments have confirmed the value of "Metasystox" used at a rate of 5 oz actual per acre against both thrips and red spider mites, and it has been shown that on healthy crops, the quantity of liquid can be reduced to 20 gallons per acre because of the systemic action of the compound. On unhealthy plants, complete cover is essential and the liquid must be applied at 40 gallons per acre.

Considerable time has been wasted through having to investigate claims that sprays have failed. In no case has this been due to failure of the insecticide, the apparent failures being occasioned by faulty application, or by the confusion of spring tails (Collembola) with thrips, an error which could be overcome by the use of simple sampling technique of which an account was published last year.

The species responsible for damage has been identified as *Thrips nigrophilosus* and not *Thrips tabaci* as was previously thought. This explains the differences observed between recent leaf infestations and previous records going back more than 20 years which refer to damage to flowers and in which infestations disappear with the rains. *T. nigrophilosus* is confined to the leaves and hence infestations in the flowers have no bearing on potential leaf damage.

Tests of methods of sprays application have continued and normal tractor spraying has been found to be the most satisfactory, whilst manual knapsack sprayers are satisfactory on small acreages. The sack method of applying dusts gives variable results and is not considered sufficiently trustworthy.

(The Pyrethrum Board of Kenya - Annual Report and Accounts for the period 1 July 1959 to 30 June 1960.)

Forest-pest Control: No new pests of any consequence have been reported. Among insects the deadwood borer, *Oemida gahani*, remains the most serious, though there is increasing evidence that sound silvicultural practice in plantations will greatly reduce the threat of appreciable damage being caused to living trees.

Armillaria mellea, the honey fungus, is certainly the most ubiquitous of fungal pests in Kenya and can be a serious threat to certain species of trees under conditions favourable to it. It has, moreover, been found in bamboo forest zones where previously it was thought not to occur. However, in the majority of cases this root disease appears to reach a "state of equilibrium" with a growing crop of trees after a few years, unless something occurs to alter this state.

Oemida gahani Dist.: Flight: Newly emerged beetles were found to fly quite strongly when released over grassland, though males were generally more active than gravid females. The maximum distance flown by a female without alighting was less than 200 ft, compared with over 450 ft for a male. A few females flew total distances of 350 ft in two or more flights but the majority did not reach 100 ft, whereas more than 50% of males exceeded this distance. Heights of from 20 ft to 40 ft were reached by both sexes, though predominantly by males. Duration of flight was reduced in a plantation.

Trap Trees: The attraction of big wounds as oviposition sites has been used experimentally to reduce the attack on select final crop trees. Inferior trees due for removal in the next thinning, were girdled or ring-barked close to attacked indigenous stumps, and results have shown that in plantations where such stumps are prevalent eggs are concentrated on these trap trees and can be easily destroyed. Final crop trees may thus be protected and the overall beetle population reduced.

(Forest Department Annual Report 1959.)

Tick-Borne Diseases

East Coast fever is no longer a major problem in the more intensively farmed settled areas, but in the Rift Valley 84 quarantines were imposed, 32 of these being in the Eldoret veterinary district.

Interest in tick control is increasing all the time in the African areas. East Coast fever is endemic at the coast and *Theileria lawrenci* infection occurred on a holding-ground on the coast stock route. In Nyanza, East Coast fever continues to be a cause of considerable mortality in the cattle belonging to the Luo tribe, and anaplasmosis, too, causes a great deal of trouble.

In the Central Province, there is a heartening interest in tick control in the plantation areas and several Council Wards are adopting the Cattle Cleansing Ordinance. In African areas of Central Province, cattle cleansing is becoming universal, and communal methods are being reduced as smallholders return to their farms and cleanse their cattle individually. In the Southern Province, the Machakos Farmers' Association is also to adopt the Cattle Cleansing Ordinance. In Masailand too, at last there is interest in cattle cleansing; a "Spraywell" pump is used in the Ngong area and a pilot dipping scheme is being planned for Narok in the Kekonyukie section.

Stick-tight flea: *Echidnophaga gallinacea*, increased in incidence on farms where husbandy was good as well as in flocks kept under poor conditions. The use of 4% DDT and 2% phenol was not completely effective and work on other insecticides was commenced.

Trypanosomiasis

The use of trypanocidal drugs in the Coast Province increased. Antrycide resistance was confirmed in an experiment carried out at Kilifi. There was an increase in cases of trypanosomiasis reported in cattle in the Sotik farming area of the Nyanza Province. In the Rift Valley Province many cases were treated in African districts.

In the Makueni Settlement of the Machakos District failure on the part of settlers to maintain bush-clearing and to control regrowth, contributed to a heavier infection rate in the cattle and the appearance of drug resistance to *T. vivax*. It was administratively undesirable to withdraw the cattle from the Settlement and the decision was made to discontinue treatment with trypanocidal drugs. In the event, owing to an exceptionally dry year, incidence of the disease subsequently decreased in the Settlement area.

Tsetse

Research: Reports are given of progress in investigations on the bionomics of the fly, of tests on various trypanocidal drugs, of immunity in cattle.

Control: The following items on the use of insecticides are noted:

Insecticidal spraying was continued in the eastern half of the grid including the perimeter road. Five further treatments were given in the months February to June inclusive, using Kiekens Dekker and Motoblo sprayers. The experiment has now been discontinued.

The Utonga Peninsula and Chausu Point. - This area was kept under observation in order to collect data on the rate of infestation by *G. palpalis* from adjoining untreated areas into the sections which have formerly been sprayed with insecticide. It was noted that reinfestation was very slow and that after two and a half years the fly numbers were still very much below those in 1956 before the work started.

Nyando River Basin. - Surveys failed to reveal the presence of any flies during the year and no flies have been caught in this area since September, 1956, when the spraying operations were completed.

The Kuja-Migori Scheme. - This was started in 1955 to eradicate *G. palpalis* from some 300 miles of the Kuja and Migori Rivers. The work during the following three years was so successful that a plan has now been drawn up which aims at the complete extermination of this fly from the Colony. Since this work began 1,000 square miles of South Nyanza have been rendered fly-free. This has involved the spraying of 692 miles of river and 63 miles of lake shore with "Dieldrex", at a cost of approximately £50,000. Four applications of 1.8% "Dieldrex" are given at three weekly intervals to specially prepared lanes through fringing thicket on the lake shore and along both banks of the rivers. Motordriven Kiekens Dekker Whirlwind mistblowers and Eclipse Warley pneumatic sprayers were used. The penetrating power of the former is much greater than that of the Eclipse sprayer but both are effective.

This year a further 134 miles on the Kuja and Migori Rivers were treated, so that the task of supervising the ever-growing field staff required to patrol the sprayed areas has become increasingly difficult. Large labour forces have been required to keep open the survey paths and the amount of progress made during the year was severely limited owing to an insufficiency of funds. However, experimental work has indicated that the use of Harris traps may make it possible to maintain an effective check on treated areas and thereby avoid the cost of maintaining an ever-increasing field staff.

No catches of *G. palpalis* were recorded in the Lower Migori section which extends from the junction of the Kuja and Migori Rivers to a point three miles below the bridge at Migori trading centre and includes the Rivers Munyu and Miroche. During the first half of the year a portion of the Upper Migori, nine miles above the bridge, was successfully maintained as a "buffer", by spraying it with 1.8% "Dieldrex" once a month; this prevented reinfestation of the treated areas by *G. palpalis* from the heavily infested country above the block.

The Lower Kuja and its tributaries including the Angoche, Ondoiche, Ratienye and Tito and the Upper Kuja have remained fly-free throughout the year. Five *G. palpalis* were caught in the Kuja delta which was treated with "Dieldrex" twice during the year. It is not known where the flies came from.

On the Awach and Oluch Rivers spraying with "Dieldrex" against *G. palpalis* was continued and a further 63 miles of riverine vegetation was treated. This operation was completed in September, when a total of 78 miles of river had been sprayed, including the work done previously.

Glossina pallidipes Experiment - Sikiri Peninsula: An experiment to determine whether it is possible to exterminate *G. pallidipes* from an isolated area by spraying with "Dieldrex" paths cut at 200-yard intervals, was begun in June, 1959. The approximate area of bush on the Sikiri peninsula is about 500 acres and the total length of spray paths cut was 11,600 yards. In August, before spraying was begun, the Apparent Density of *G. pallidipes* was 215, as estimated by fly patrols. This was reduced to 1.2 after the first application in September, to 1.1 after the second in October and to 0.5 after the third in November. Since then no further *G. pallidipes* have been caught by patrols. An interesting point, however, was brought out when eight Harris traps were introduced in to the area in November. Although the Apparent Density of flies caught by fly teams on one section during the whole month was 2.5, the traps caught four *G. pallidipes* within the first week after they were set up. Moreover no flies were taken by fly patrols in December but nine flies were caught by the traps. This shows that Harris traps are far more efficient in detecting the presence of *G. pallidipes* than the ground patrols. The Apparent Density of *G. pallidipes*, which also existed in the area before treatment in August was 102. This was reduced to 5.6 in September after the first treatment and to 4.2 in October after the second, and since then no further *G. palpalis* have been taken. The Apparent Density of *G. brevipalpis* which also occurred was nine in August. This was reduced to nil after the first application of insecticide in September. No further flies of this species have been caught since then.

(Annual Report of the Veterinary Department for 1959.)

NORTH BORNEO

Timber Borers: Borer damage in felled logs continued and was mostly caused by ambrosia beetles. In general, provided extraction is reasonably rapid, borers do not penetrate beyond the sapwood and none of the licensees use log insecticides.

Preservation: It has been shown that, in the ground, red seraya is slightly more durable than keruing, but that both respond well to a cold soaking treatment with certain proprietary preservatives. The test ran for three years.

(Annual Report of the Forest Department for 1959.)

Malaria Control: A joint scheme for the control of malaria sponsored by the Government, the World Health Organisation and United Nations Children's Fund began operations in July, 1955. The World Health Organisation provides senior technical staff, UNICEF provides a great deal of equipment such as vehicles, insecticides, sprayers, laboratory materials and other supplies, whilst the Government provides a Malaria Control Officer, the junior technical staff and labour force, and the cost of running the scheme within the Colony. The headquarters of the pilot project are situated at Keningau in the Interior Residency.

As indicated above, the method of control employed in 1959 has been twice-annual spraying with a residual insecticide (either DDT or Dieldrin) combined with mass administration of anti-malarial drugs, namely Chloroquine and Pyrimethamine, given at the time of spraying. This method has proved so effective that the previously sensitive index of transmission namely, the infant parasite rate, is beginning to lose its value, and in certain places passive surveillance has begun. In Labuan active surveillance is under way, but no case of malaria has been discovered during the year on that island.

The vector of malaria in most parts of North Borneo is *Anopheles leucosphyrus balabacensis* but it is also considered probable that in certain coastal districts the vector may be *Anopheles sundaicus*. Entomological studies also indicate that *Anopheles barbirostris*, which has been found infected with sporozoites, may at times act as a carrier. During 1959 operations were carried on in the whole of the Interior Residency, part of the West Coast Residency and in part of the Sandakan and Tawau Residencies.

It is not surprising to find in reports from the various hospitals of the Colony differing accounts of the prevalence of malaria. Thus from Labuan the Medical Officer reports that the pattern of disease is now changing and he sees more and more of the conditions normally encountered in more sophisticated countries. Throughout the Interior Residency the incidence of malaria has been very greatly reduced with consequent general improvement in the health of the population as a whole. In at least one district, the Murut population, whose survival as a race had at one time been considered to be in doubt, are reported as having large numbers of healthy children. This can in no small degree be attributed to the absence of malaria. Contributing to the happy result is the activity of a Mission which has worked hard to improve the dietary and other conditions of life for the Muruts. So far as the island of Labuan is concerned, there has been no reported malaria in the past three years, and a diligent search for malaria has failed to produce a single case. Recent tours by Medical Officers in the Labuk and Kinabatangan districts of the East Coast have indicated that the incidence of malaria is very greatly diminished-and a Medical Officer touring the hinterland of Papar also reported hardly any malaria. Indeed, the only two districts of the Colony now completely unaffected by the campaign are the Ranau and Kudat districts. These two districts are to be included in the programme for 1961.

Following on these encouraging results and in consultation with W.H.O. and UNICEF, it is now proposed that the year 1960 shall be devoted to a consolidation of the existing position and to the recruitment and training of additional staff in preparation for an all out assault on malaria on a Colony-wide basis. An eradication campaign is planned to commence in 1961 and last for approximately three years. It is hoped that assistance will be forthcoming for this campaign from the Malaria Eradication Special Account of the United Nations.

(Annual Report of the Medical Department for the Year 1959.)

NORTHERN RHODESIA

Forest Pest Control: Elephant damage was reported from the Rhodesian teak forests. Browsing by buck was reported from Central and Western provinces in *citemene* regeneration areas. Termite attacks in plantations were reported from several provinces especially towards the end of the unusually severe dry season. Losses due to termites have been greatly reduced, however, by treating planting stock with chemical repellents.

Timber Preservation: A timber durability graveyard was established and samples of forty-four timber species, both treated and untreated, were placed under test.

Tests were carried out on the preservative treatment of round and squared timber of eight different species. Absorption by round timbers was good but by squared baulks was very irregular and unsatisfactory. Some eighty billets of local timbers were treated with two preservatives of varying strengths and then placed in an underground graveyard to discover the minimum efficient treatment required for timber used underground in mines.

A series of tests showed that both indigenous and softwood fence posts could be given adequate preservative treatment quite cheaply and simply by the sap replacement method.

(Ministry of Land and Natural Resources - Annual Report of the Forest Department for the Year 1959.)

NYASALAND

Agriculture - Coffee: White stem borer was troublesome where growers failed to apply control measures and a minor attack of leaf rust occurred in the Misuku area of the Northern Province. A research programme financed by a grant from the Colonial Development and Welfare Fund to study *Fusarium* dieback disease which reached epidemic proportions in some areas was started during the year.

Veterinary - Rabies: The scheme for the mass inoculation of dogs against rabies continued in 1959 and was extended into the Southern Province. However, the civil disturbances which led to the declaration of a State of Emergency, and the preoccupation of the staff in this connection, prevented the inoculation campaigns being as widely effective as was desirable. Nevertheless the very effective campaign in 1958 in the

Central Province demonstrated the value of the scheme by spectacularly reducing the number of cases diagnosed during 1959 in that Province. In fact only two from this area were diagnosed at the Laboratory and very few suspicious cases were reported. Despite the somewhat patchy coverage in the Southern Province a certain amount of protection was afforded as shown by the fact that 38 cases were diagnosed as against 57 in 1958. Two unfortunate features of the disease were observed during the year, however, one being the spread of the disease to areas which had hitherto been regarded as relatively free, and the other the establishment of the disease in jackal.

Tickborne diseases: Tickborne diseases remain the most insidious cause of loss to the stockowner, the disease of greater importance being East Coast fever for which there is no curative treatment. Control is by dipping and there are now established some 110 dipping tanks in the country where the stock may not only be dipped but where the stockowners may receive advice and assistance and where they may see demonstrations of management techniques and simple stock buildings. Most dipping tanks also possess facilities for the purchase and drying of hides and skins and some have creameries established in close proximity to them.

Tsetse Control: Some surveys of individual areas were carried out during the year, mainly to check any alterations in tsetse fly distribution since the major survey of 1953. A number showed a perceptible decrease in area of infestation or fly density.

Short experiments were also made in the effect of insecticides on the *Glossina brevipalpis* belt in Karonga District.

(Nyasaland. Report for the Year 1959. London: H.M.S.O. 1960.)

Forest Pest Attack - Termite: Mr. W.V. Harris of the Colonial Termite Research Unit visited Nyasaland in February in connection with termite damage to eucalypts. As a result of his report it is hoped that a member of the team will be able to come to Nyasaland in 1960 for a period of two years with the object of studying this problem in all its aspects.

During the year some improvements in the control of termite damage were brought about by the use of better nursery stock, by improved planting technique, and by the application of aldrin at the time of planting. Although this indicates that some measure of success can be obtained, it cannot yet be claimed that the termite problem has been overcome.

Rats: At Chikangawa and Zomba Mountain Forests, damage by rats was again successfully controlled by the use of "Sorexa" rodenticide. Poison baiting was carried out over 742 acres at Chikangawa, and it is believed that the problem of rat-damage in shortgrass areas can now be considerably minimized, if not entirely overcome. Three species of rats from Chikangawa were identified at the Bulawayo Museum as *Lophuromys aquilus*, *Pelomys fallax* and *Grammomys dolichurus*.

Baboons were reported as having pulled up young planted pine trees at Dedza.

(Annual Report of the Department of Forestry for the Year ended 31st December 1959.)

Veterinary:

Tick Control: The tick-borne diseases have always been, and are, the most important single cause of losses and ill health amongst the stock population and the implementation of the Department's long term plan to cover all the stock-containing areas with an adequate number of dipping tanks was taken a step further by the completion of the programme of dipping tank construction made possible under Colonial Development and Welfare Scheme No. D2883.

The total immersion of stock in a dipping tank ensures control at low cost and, by their frequent attendance at the dipping tanks, enables them to be closely examined at regular intervals when advice can be given on management techniques and minor ailments treated by the use of simple cheap remedies.

Dipping is in general well accepted in the Southern and Central Provinces and less so in the Northern Province although the success of the newly installed dipping tanks in the Mzimba District of that Province has so far confined some reluctance to dip to the Karonga District. Each unit consists of a prefabricated steel tank with concrete or brick ancillary works and a two or three roomed house with the usual offices. In addition soil conservation and water conservation work is carried out in the immediate vicinity of the tank as required, where necessary a road to each tank is constructed and at many tanks demonstration centres are created. In all, 41 tanks have been built of which 28 are in the Northern Province.

Tsetse Control: Tsetse belts in Nyasaland are limited in extent and there is evidence that they have contracted during the last fifty years from an area of about 5,000 square miles to possibly some 3,000 square miles at the present time. In this period also the problem of human trypanosomiasis has decreased to the point where it can be regarded as being of negligible importance. The reason for this contraction is the pressure of the human population on the very restricted land area of the country which has resulted in the tsetse fly being confined to the agriculturally less desirable localities.

Nevertheless the tsetse and trypanosomiasis problems of Nyasaland are of very great interest since they concentrate within a comparatively small area the problems that are besetting very much larger countries on a much bigger scale. Furthermore, and arising from the comparatively small area involved, it is possible to make a more detailed evaluation of the position, and of the remedial measures necessary to control it.

In brief it is considered that the permanent answer to trypanosomiasis under the conditions encountered in this country in which amongst other things cattle are communally herded, lies in the use of a prophylactic drug over the whole area with a sanative drug of a different type as a curative in breakdowns. Dipping tanks are also needed to consolidate the position by ensuring regular inspection, and a reduction in the number of external parasites. It has been noted in the Lower River that as an animal becomes infected with trypanosomiasis its resistance to ectoparasites diminishes and such animals become heavily infested with ticks. The addition of a residual action insecticide to the dipping fluid might usefully be used in an attempt to control biting fly populations.

(Annual Report of the Department of Veterinary Services and Animal Industry for the Year 1959.)

Tsetse Control: The establishment of a settled programme was aggravated by staff difficulties. No material progress was made during the year in implementing the policy of integration of the tsetse programme with agricultural expansion. Arrangements for mapping the agricultural position in each District were approved early in the year but no results were at hand by December.

The surveys were aimed mainly at identifying changes in the tsetse areas since the time of the Tsetse Survey. At Liwonde and Chiuzi, however, more intensive observations are being made with a view of identifying more exactly the source of flies carried to the Kasupe and Fort Johnston fly post respectively. It is now apparent that the relatively small number of tsetse flies carried to Kasupe are collected from a wide area and in the main are carried secondarily from Liwonde ferry which is a focus for traffic of all kinds.

A number of the surveys revealed a decrease in tsetse infested areas or diminished fly populations. In a brief visit no sign of the former pocket of fly in the Kasungu Game Reserve could be found. The tsetse infested area has retreated northward between Mua and Chipoka. There is general decrease in the northern fly sector in Chikwawa District (Mwanza-Nkombedzi). In general it may be said that at present the fly population in Nyasaland is static or decreasing.

The Karonga reclaimation scheme suffered severely from effects of the emergency. However, two small trials of insecticide were made, spraying the sides of patrol paths with 4% dieldrin from a "Motoblo" machine in sectors of persistent fly catches. The result was disappointing in that there was little effect, either immediate or long-term, on the fly catches. This is in contrast to previous trials of non-residual applications of gamma BHC with "Swingfog" machines, which produced at least a very obvious short-term reduction in flies. The clue may lie in the location of the resting sites of *G. brevipalpis* at a higher level than was reached by the heavier dieldrin spray. The unexpected result, however, emphasizes the empirical nature of the work on this tsetse fly.

(Annual Report of the Department of Game, Fish & Tsetse Control for the Year ended 31st December, 1959.)

RHODESIA

Agricultural Pest Control

Maize: A spraying trial at Beatrice against the maize ladybird, (*Epilachna similis*), was satisfactorily concluded and indicated that toxaphene, dieldrin and malathion were satisfactory insecticides. No data on dosages of dieldrin emulsion which could be used as a foliage spray were available so an arbitrary dosage of 1:24 of 19.5% emulsion was used and applied at 12 gallons per acre.

Malathion, at 1½ pints of 50% emulsion appeared to be the most economical treatment. An area at Gwebi, badly infested with the cutworm, *Euxoa segetis*, was sprayed with dieldrin W.P. ½lb (50%) per 14 gallons of water per acre. Counts of damaged plants were made in treated and untreated areas. Unfortunately, interplanting was carried out in the treated zone which meant that the counts could only be taken as a general indication of damage there. In addition germination was rather irregular. The indications were, however, that dieldrin is likely to be a useful insecticide and should be used in future experiments against cutworm.

There was a small outbreak of *Systates exaptus* on maize early in the season. Distribution within maize lands was patchy and confined to fairly small plants during December. Only one report was of severe infestation, from the Mazoe area. Observation has shown that if a farmer is on the lookout for infestations during the early growth period of the maize, action can be taken and the pest controlled by "spot spraying" the affected areas with DDT. General treatment of the fields does not seem necessary if the farmer has taken the trouble to inspect his fields adequately.

(Report of the Chief Entomologist for the Year ended 30th September, 1957. Bulletin No. 1988.)

Agricultural Pest Control:

Beam Stem Maggot *(Agromyza phaseoli Coq.):* As investigations carried out in East Africa had indicated that good control of bean stem maggot could be obtained with insecticidal seed dressing, trials were carried out at Salisbury to determine whether similar control could be obtained under local conditions. Good control was obtained by using 0.2% actual insecticide by weight to seed with endrin, dieldrin or aldrin admixed as emulsion. DDT, Malathion, "Chlorthion" and "Rogor" were not effective. Results have been prepared for publication in the Rhodesian Agricultural Journal.

Pasture White Grubs *(Eulepida mashona Arrow):* Trials were completed at Grasslands Research Station in which various insecticides were compared for pretreatment of lands for control of white grub. The plots were sown to a ley pasture with Katambora Rhodes Grass and insecticides were incorporated into the surface layers of the soil by light discing. Good control was obtained with 1 lb of technical dieldrin per acre. One hundred per cent pastures were established. Eleven to fifty per cent of the pasture in the untreated plots failed to become established. Results are to be published in the Rhodesian Agricultural Journal.

Cutworms: The cutworm is a serious pest of many agricultural crops. During recent years cutworm damage has been particularly severe in the Gatooma area. Trials were carried out at two farms near Gatooma. Various insecticides were compared as seed dressings, dust in drills and dust on top harrowed into the soil. The results were not conclusive but they indicate that seed dressings are unlikely to be useful as a control measure against this pest. Placement of insecticides, notably dieldrin around the base of plants, was found to be successful when the soil was moist. It was concluded that dieldrin applied under hot dry conditions should be worked into the top two inches of soil.

Pink Bollworm *(Platyedra gossypiella):* An outbreak of pink bollworm was discovered infesting cotton grown in the Sabi Valley. This insect, an important pest of cotton in many parts of the world, had not previously been found in Southern Rhodesia. It seems probable that the infestation spread from cotton growing areas in Mozambique. Phytosanitary measures were introduced defining infested and quarantine areas, enforcing a closed cotton growing season, and requiring fumigation of all seed cotton before removal from the quarantine areas. The co-operation of cotton growers was obtained in the area with destruction of alternative host plants. Biological investigations have been undertaken with the co-operation of the Cotton Pest Research Scheme, Gatooma. These have been directed towards determining whether pink bollworm larvae will enter diapause and whether they are able to survive in the absence of cotton plants on alternative host plants. Results indicate that a diapause stage is not formed but that pink bollworm will be able to carry over from one cotton growing season to the next on *Hibiscus congolensis*. The latter is restricted to lowveld areas.

Stored Grain: The Khapra beetle, *Trogoderma granarium*, which was the cause of serious losses in the past, has been brought under control by the measures practiced; it is now rarely found in central grain stores. A better understanding of the problems connected with fumigation of bulk grain in silos in Southern Rhodesia and Northern Rhodesia has been obtained. Difficulties remaining are largely due to material or structural faults. Further experience with *Phostoxin* fumigation has confirmed that this fumigant is very satisfactory for use with bulk grain when methyl bromide cannot be used in silos.

Outbreaks of two species of moth, *Ephestia cautella* and *Plodia interpunctella* were serious in many grain stores in Southern and Northern Rhodesia. Although these caused relatively little weight loss to stored grain, webbing produced by the caterpillars covers sacks and joins grains making cleaning difficult. Investigations are continuing with the evaluation of different insecticides and formulations for control of stored products pests under conditions in this territory.

Veterinary

Tick Control: In general it can be stated that there has been a distinct improvement in tick control although a considerable leeway has as yet to be made up. Mortality from tick-borne diseases also showed a decline. Prewar, stockowners had to depend on arsenical preparations for tick control but nowadays the position is completely changed in that modern organic synthetic acaricides effectively influence the position. The trouble lies in the fact that these modern acaricides are not correctly used nor is dipping undertaken regularly. Too many stockowners look to the organic acaricides as being the solution of their tick problems instead of recognizing the necessity to overhaul their dipping programmes and practice regular, efficient dipping in correct dip washes.

The modern acaricides have one serious drawback in that there is no efficient dip side test to ensure that cattle are immersed in an effective tick-destroying solution as in the case with arsenic. Furthermore they are expensive with the result that stockowners are inclined to economize by under-charging the dip washes which in the long run leads to inefficiency and results in ticks developing a resistance against them. At the same time tick flushes normally coincide with major crop activities with the result that dipping may be neglected in favour of other more pressing work.

Tsetse Control: One of the new ideas tried out during the past year has been the control of water holes in the hope that the game animals would tend to leave the operations area in search of other water. The control was achieved by spraying all isolated surface water with diesoline and BHC (surplus from the aerial smoking campaign of 1957) this rendered the water quite unpalatable and animals have avoided these places ever since.

Insecticidal Operations:

Kapondo: In August and September, 1958, a small experimental insecticide scheme was undertaken in the Kapondo area in the north of the Umniati East section. It was intended to attempt to eradicate *G. morsitans* from the area of the Upper Urengi watershed (about 16 square miles) by the application of a solution of dieldrin as "Dieldrex" to as large a proportion as possible of the dry season resting sites of tsetse within the area.

The first application was commenced on 6th August and completed on 14th August. A total of 689 gallons of 1.8% dieldrin was used. One "Motobolo" machine and three "4 Oaks" sprayers were employed to apply the insecticide.

As the experimental fly-rounds within the area indicated residual "pockets" of tsetse, a second application of 130 gallons of 3.7% dieldrin was applied to these in the third week of September.

It was unfortunate that the comparatively cold overcast weather at the beginning of August resulted in low availability of tsetse in the area before the commencement of the spraying and probably delayed the hot season defoliation of the vegetation. The comparatively low availability of tsetse made the assessment of results difficult but the available data indicated that the spraying operations had resulted in an 85% reduction in the availability of *G. morsitans* within the area. This percentage reduction is unsatisfactory and the remaining tsetse would, in normal circumstances, quickly recolonize the area. However, as the area treated was not isolated from the surrounding low density tsetse populations, some of the apparent residual population may have been due to re-invasion from outside the area.

This experimental scheme was useful in demonstrating the many difficulties inherent in the control of *G. morsitans* by the ground application of residual insecticides.

Chiredzi: The spraying was undertaken in April, using knapsack sprayers containing 5% DDT suspension, of 120 miles of riverine fringe, paths, pans and waterholes: 1,340 gallons of the insecticide were used. The areas treated included both banks of the Chiredzi River from Chidumo Clinic to the Lundi: the north bank of the latter to the Mahonde River and of this river, both banks. Both banks and riverine fringe of the Nyamasikana River were treated as well as all cattle, cattle paths and sledge tracks.

Dieldrin Spraying: In this operation paths were cut, 40 yards apart and at right angles to the river bank, through 800 acres of thicketed woodlands on the east bank of the Chiredzi. Elsewhere, because the bush was less dense, no paths were cut and distance between spraying machines was kept by eye. The operation took ten days, from 17th to 22nd September and from 3rd to 7th October. Ten two-stroke engine portable spray pumps were used, each with a team of two operators, two carriers and a panga man. Supervision was carried out by African Field Assistants. These ten teams worked as a unit, keeping line abreast, each at a distance of 40 yards from the team on the right. A 3.6% suspension of dieldrin was used. This was prepared in drums at the camp and transported by jeep and trailer, following the machines. A total of 2,700 acres was sprayed, using 1,370 gallons of the suspension, thus giving a coverage of 0.6 gallons per acre. The total cost per acre including labour and fuel was 6/7d. During the best day's work the team of ten machines covered 465 acres.

Chipinga: In January a 5% dieldrin emulsion (diluted from Shell "Dieldrex 15") was sprayed by means of pneumatic knapsack sprayers on to the woody vegetation along the bush edge of the Border clearing where it crosses the Chiredzi and Inyamadzi valleys, and on to woody vegetation forming the boundary of Stirling Farm within the Inyamadzi Valley. During February the spraying was extended to include part of the Busi Valley within the Border clearing and was completed by 9th March, A front of approximately ten miles was covered using 735 gallons of insecticide. The intention was to give protection to farms adjacent to the border clearing lying to the north of Mount Selinda, by providing an insecticidal barrier to the passage of tsetse along these watercourses from Portuguese East Africa.

The protection given by the application of insecticide might be expected to last for three months January to March. Comparing the incidence of trypanosomiasis during January March, 1958 (before spraying), with that during January to March 1959 (after spraying), on protected and unprotected farms it is evident that spraying has been accompanied by a significant reduction in the incidence of disease.

(Report of the Secretary to the Federal Ministry of Agriculture, for the Year ended 30th Sept. 1959. Salisbury, 1960.)

SARAWAK

Pest Control Services: The main effort in pest control work has again been concentrated on the rice crop, both wet and dry. In order to ensure that supplies of pesticides, which are given free, are quickly available to padi planters who need them, the number of places where they can be obtained has been increased still further with the co-operation of junior administrative officers and the headmen of long-houses and villages. Although much still needs to be done to convince planters of the value of the service and the necessity for asking for assistance immediately an attack is noticed, the increasing use made of the service can be illustrated by the greater amount of pesticides distributed in 1959, as shown in the table below. The extent of pest attack was similar in all three years.

	1957	1958	1959
"Agrocide" and similar products	36 cwt	115 cwt	111.5 cwt*
Zinc phosphide	8 cwt	14 cwt	19.6 cwt
"Meta Fuel"	39 packets	23 packets	111 packets
"Dieldrex"	-	31 gallons	33 gallons

*This figure is due to the introduction of a new formulation, the active ingredient content being some four times that of the former product.

The use of 'Swing-fog' machines, using a mixture of "Dieldrex" and diesel oil, has proved very effective in the control of the padi bug, *Leptocorisa acuta*, and is a very popular service among padi planters. The most widespread and serious pests were again army-worm, *Spodoptera mauritia*, and rats.

Pepper Foot-Rot: The stage has now been reached when it is possible to predict how foot rot develops. The pepper is normally planted in soil where the pathogen, if present at all, is in such small amount that the plants cannot be immediately infected. If not already present the pathogen may be brought in at some future date by soil wash or on the tools and feet of people entering the garden. Once present the gardener through the practice of clean weeding probably spreads the pathogen to other parts of the garden and infection of the minor roots begins to build up. The first visible sign that the disease is present is a characteristic blackening of portions of the lower leaves touching or near the soil surface. This symptom now recognised by the Plant Pathologist is apparently not regarded as serious by the pepper gardener. The infected leaves fall and add to the build-up of the pathogen in the soil which eventually gives rise to a severe attack on the root system followed by the fairly rapid death of the vine.

Resulting from an observation on the application of a copper fungicide to the soil there were indications that by using this method the rate of spread of the pathogen could be appreciably reduced. There is, however, no simple remedy to combat foot rot of pepper and further work on the practical side of control is required.

(Annual Report of the Department of Agriculture for the Year 1959.)

SIERRA LEONE

Cocoa, Black Pod: Black pod diseases of cocoa - *Phytophthora palmivora* Butler - It is apparent that black pod disease is not severe in all farms in the South-east and South-western circles where cocoa is grown, but it is only serious in isolated farms. Black pod incidence was reported to be high in the Gaura and Mandu chiefdoms. The highest incidence being recorded at Goo (Mandu) where 50% of the trees in a 2-acre farm had an average of 8 black pods per tree. This is a considerably greater incidence than any detected in 1957.

Experimental spraying to control black pod was continued at Kpuabu (Gaura) during the season May-November. In addition spraying trials were carried out at Kpai (Small Bo) and Neikabo (Nongowa). The treatments at Kpuabu were:-

(i) underbrushing and 1.0% Carbide Bordeaux applied to developing pods at 1, 2, 3, and 4-weekly intervals;

(ii) underbrushing and 0.4% 'Perepod' applied at fortnightly intervals;

(iii) underbrushing and 0.4% 'Kopapod' applied at fortnightly intervals;

(iv) underbrushing and 1.0% Carbide Bordeaux applied at fortnightly intervals;

(v) Sanitation-underbrushing alone with periodic removal of diseased pods;

(vi) control (untreated)

The results indicate that spraying with any of the fungicide tested protected pods from black pod disease, but that 1.0% Carbide Bordeaux was superior to both 0.4% 'Perepod', and 0.4% 'Kopapod'. There seems to be very little difference in the level of black pod incidence between the control plots (no treatment) and the sanitation treatment, where diseased pods were removed periodically.

(Report of the Department of Agriculture, 1958.)

SINGAPORE

Malaria Control: For the sixth consecutive year Singapore had yet another year of freedom from malaria transmission. The climate and ecological conditions are such that the country is potentially malarious. The malaria organisation must be ever vigilant because out of 2,842 different anopheline collections made in routine surveys during the year 161 were found to be *A. maculatus* and 90 were *A. sundaicus*. With the decentralisation of malaria control to the future District Councils, the overall co-ordination of malaria programmes and check surveys by the Central Malaria Laboratory are essential.

The Department still depends on anti-larval measures in the control. Such measures consisted of subsoil drainage, permanent surface drainage or oiling of different breeding places for *A. maculatus* and *A. sundaicus*. Residual spraying which has taken such a prominent place in malaria control in other parts of the world is considered of limited value in Singapore. It has been employed in the surrounding islands and around Paya Lebar Airport.

Apart from malaria control, mosquito complaints were dealt with from the public as well as from Government premises.

Seventeen experiments on anti-malaria oil samples submitted for tender were tested in the laboratory for toxicity, spreading pressure, viscosity, permanency of oil films during the year.

The amount of anti-malaria oil used was 116,692 gallons. 542 gallons of kerosine was used in controlling breeding in seepage wells, and 3,420 gallons of residual insecticides (BHC and "Dieldrex") were used in residual spraying of the Southern Islands, and around the International Airport.

Yellow Fever: *Aedes stegomyia* mosquito control within the airport and 880 metres from the airport perimeter fence has been carried out vigorously as in previous years and as a result not a single collection of *Aedes (S)ægypti*, the domiciliary yellow fever vector, was made during the year within the control areas.

The usual measures practised during previous years were satisfactorily maintained during 1958. This included clearing of artificial containers, check surveys, destruction of natural breeding places and clearing of secondary vegetation.

Spraying of houses in the controlled area around the International Airport and in the Southern Island was done once in four months.

Swing fogging operations were carried out on eight occasions using 60 gallons of dieldrin emulsifiable concentrate.

Aircraft Disinsectisation: All aircraft from Bangkok landing at the International Airport at Paya Lebar were checked for flies to assess the danger of transmission of cholera by this route from 13th June to 16th August, 1958. A total of 74 aircraft were checked and 146 collections of common house flies, mostly alive, were made. The following insects were caught in the planes checked.

Musca domestica - common house flies	146 collections
Lucilia caesar - green bottles	3 collections
Phlebotomus papatasii - sand flies	3 collections
Periplaneta orientalis - cockroach	1 collection
Culex fatigans	1 collection
Culex sitiens	1 collection

(Report of the Ministry of Health for the year ended 31st December, 1958.)

TANGANYIKA

Forest Protection

Animals: Elephant, buffalo, pig and buck were the main enemies among the larger animals. The Northern Province found that electric fences were not so effective against the last two as was previously thought and had to resort to expensive wire netting. The cost of maintaining electric fences proved to be quite high - £7 a mile in the Northern Province. In addition to damaging trees, elephant again had their enjoyment of boundary posts. The use of carbide bangers at Rongai did little to frighten game but kept the licensed cultivators awake. A species of molerat effectively felled *Eucalyptus maideni* up to twelve feet high by eating roots of an inch diameter. The system of germinating seed in vermiculite before placing young seedlings in the beds had to be abandoned at Shume because of the depredations of birds and rodents on the tender seedlings in the beds. The same difficulty was experienced in the Northern and Southern Highlands Provinces.

Insects: *Oemida gahani* was found to be widespread in *Cupressus lusitanica* at West Kilimanjaro, but none was found at Olmotonyi. Attacks of gall fly continued to be severe on mvule in the Rondo reserve, and a Chrysomelid beetle *Colasposoma*, defoliated mvule at Ziwani, Mtwara, and also attacked teak, *Cassia siamea and Eucalyptus saligna.*

Wood Preservation tests: Most preservatives evaluated were proprietary and information on their efficiency is confidential. In the case of creosote, however, it can be said that all samples given absorption treatments were free of attack, while those given surface treatments only were destroyed as soon as any penetration was made through the creosote skin.

(Ministry of Natural Resources - Annual Report of the Forest Department for the Year ended 31st December, 1959.)

TONGA

Agriculture: Under the zealous activity and supervision of the Pest Control Officer the depredations of the rhinoceros beetle have been kept well under control in the Vava'u district. The beetle has appeared in some new locations, as inevitably it must, while control is dependent upon human searching, hand picking and the colossal task of destroying possible breeding media. The main producing area has benefited. This is very clear to anyone who has seen badly infested areas in other territories of the Pacific.

Fumigation measures were regularly carried out at Vava'u and Nuku'alofa. Methyl bromide gas was used as the fumigant at both stations, approximately 133 lbs. of gas at Vava'u and 42 lbs. at Nuku'alofa. It is reported that 26,798 packages were fumigated at Vava'u during the year. This high figure at Vava'u is due to the practice of fumigating everything that is being taken out of Vava'u to be landed at any other destination within the Kingdom.

All luggage and personal effects of passengers arriving via Fiji and Western Samoa are subject to inspection and fumigation where necessary.

Scab moth is the major pest of bananas. DDT 2% dust is a satisfactory control and was made available to growers first by the department and subsequently by the Produce Board. The use of the dust by farmers continues to improve.

The yellow melon beetle is a serious pest, if neglected, of all melons and cucumbers. It is controlled with arsenate of lead either as a spray or powder dust. Supplies were on sale by the department and farmers are making increasing use of it, to control this beetle, cut-worms, and cabbage moth grubs.

Bunchy-top virus disease of bananas is widespread, but of low intensity. To persuade farmers to dig out and destroy infected plants remains a constant job of departmental staff.

Rodent Control: The rat population and the damage done by them remained as heretofore. Effective control measures to embrace the whole rat population would be a formidable undertaking in men and money. Metal banding of coconut palms would certainly increase copra yields but the rats would be driven to attack food crops in the fields and to invade the villages in serious numbers. Thus banding would have to be coupled with extensive organised poisoning. Further investigation of the methods and costs are being made.

(Report of the Agricultural Department for the Year 1959. Nuku 'Alofa 1960.)

Mosquito and Fly Control: This work was carried out using a solution of 5% DDT in oil for the spraying of swamps, water pools and pit latrines. 466 lbs. DDT powder in 1,078 gallons of oil were shipped to Ha'apai, Vava'u and Niuatoputapu. 873 gallons of 5% solution were used in Tongatapu. In all about 195 acres of water surface were sprayed and 3,276 pit latrines treated.

At Niuatoputapu following advice from H.B.M.'s Commissioner and Consul, Mr. Weston, an experiment was made with the introduction of Gambusiae fish. These small fish attack mosquito larvae and so help to minimise the nuisance. This introduction has been found to be successful, the fish have thrived and efforts will be made to obtain further batches.

(Report of the Ministry of Health for the Year 1959.)

NETHERLANDS

Fate of Deposits on Plant Surfaces: Experiments have been started to study the persistence of DDT and parathion residues on foliage when exposed to weather. Ivy, *(Hedera helix)* has been selected as test plant because of the drought-resistant quality of its leaves, when cut from the plant. The whole study will comprise a series of large scale experiments over a period of 2 years. The weather factors, rainfall, temperature and radiation, will be studied both in the field and in the laboratory.

The research technique is as follows:

After spraying the insecticide at a quantity of 2 ml per leaf by means of the vertical spraying apparatus of Ten Houten & Kraak, each leaf is provided with a glass tube containing water. The leaves are kept in the laboratory for 6 hours for the drying of the residue. The leaves are then transferred to the field where they are fixed, together with their glass tubes, to wooden trays. These trays face south-west and are placed 1 metre above the soil surface.

Leaf samples are taken daily over a period of 7 days for DDT and of 5 days for parathion. The amount of residue on exposed leaves is determined by the Calandra-test method of Loosjes. Simultaneously a number of leaves are taken for the chemical determination of the insecticide. The author deals with the results of the field experiments carried out during the summer of 1959.

(Ir. H. S. Fahmy. From the Canadian Insecticide Newsletter, June 1960, 9, (6)).

SOMALILAND

Malaria Control: A malaria survey by the World Health Organisation begun in April, 1958, was continued throughout the period. Much valuable data has been collected and the entomological survey was being continued at the end of 1959. It is hoped researches may be complete by the end of 1960 and a decision as to control or eradication measures will then be taken. Temporary measures to keep seasonal epidemics in check were continued in the affected areas.

(Somaliland, Report for the Years 1958 and 1959, London: H.M.S.O. 1960.)

ECONOMICS

An Announcement

Economic Studies

We have already announced to our readers that we are taking an increasing interest in the economics of pest and disease control. We are also making studies of the present usage and future demand for pesticides in various countries. These studies will be issued from time to time as separate C.P.R.C. reports and will be available price 25/- each, post free surface mail, except that a report will be supplied free on request to any free list recipient of PANS in the particular countries concerned. We have available:-

"The Market for Pesticides in Central Africa"
(Southern Rhodesia, Northern Rhodesia and Nyasaland)

The report contains a list of the main pests and diseases affecting crops in the countries mentioned, the total area of each crop and the approximate average area to which it is worthwhile applying remedial measures for each pest, the methods being used to control the pests and diseases and the amounts of the various pesticides actually being used on each pest at the present moment. It also contains an important concept we call the Maximum Economic Consumption, that is the greatest quantity of each pesticide that farmers could use with economic advantage themselves; this is not to say that they are using it, or ever will use this maximum quantity, but it is a ceiling figure and consequently of interest to agricultural administrators and manufacturers. It may however be noted that in many advanced agricultures, pesticides are used up to the maximum (for instance fruit growers in Britain) and in some in excess of it (for instance cotton growers in Central America). The report also contains forecast estimates of consumption five and ten years ahead and general notes on the products.

There are a number of tables arranging the information in different ways so as to make it readily available and also an estimate of the monetary value of the different totals.

We hope these reports will prove of value in documenting the pesticide situation.

I. Pesticide Exports from the U.S.A.

The following table gives the dollar value of pesticides exported from the U.S.A. in 1959 and 1958.

Dollar Value of Pesticide Exports from U.S.A.

$'000

	1959	1958	Percent increase or decrease on 1958	
Nicotine sulphate	8.9	56.4	-84%	
Copper sulphate	674.5	1,175.9	-43%	
Lead arsenate	276.4	412.4	-33%	
Calcium arsenate	12.2	80.8	-85%	
Pyrethrum	223.7	183.7	+22%	
Paradichlorbenzene	366.0	389.7	-6%	
DDT, Tech.	2,891.5	5,067.9	-43%	+ 25%
DDT, 20-74%	1,314.6	1,750.8	-25%	
DDT, 75%	19,325.3	11,992.8	+61%	
BHC	2,081.4	1,482.2	+34%	
2,4-D & 2,4,5-T	2,665.3	2,929.1	-9%	
Other herbicides	4,049.7	5,986.9	-3%	
Organo phosphorus	7,980.0	4,243.7	+47%	
Other "Polychlor" prods.	16,068.9	17,625.1	-8%	
" Agric. insecticides	8,465.9	10,621.2	-20%	
Fungicides	8,034.6	7,641.7	-5%	
Fumigants	1,065.0	1,112.0	-4%	
Household	6,039.9	5,543.7	+9%	
Disinfectants	4,107.8	3,508.8	+17%	
	$ 85,652.1	81,804.8	+4.7%	
	£30.6 million	£29.2 million		

(Source U.S.D.A. per Oil, Paint and Drug Reporter, 7 Nov., 60.)

Exports increased by $3.8 million, 4.7%, but this is mainly due to an increase ($7.3 million) in exports of 75% DDT wettable powder, which was mostly for the World Health Organisations malaria clearance campaigns. Small increases were shown by pyrethrum ($0.04 million), BHC ($0.6 million), organo-phosphorus ($3.8 million), household insecticides ($0.5 million) disinfectants ($0.6 million). All other pesticides showed a decline and the only significant increase is in the organo-phosphorus group.

2. Apple Scab and Mildew Control

Mr. H. I. Kingston in the "Commercial Grower", 19 April, 1960 p. 399, gives some figures on the costs of materials in the control of apple scab and mildew.

Spray	No. Treatments	Per acre cost of materials per season
Captan	10	£ 23 0. 0.
Captan and Karathane	10	£ 35 0. 0.
Sulpham	10	£ 18 10. 0.
Phelham	5	£ 13 0. 0.
Sulpham	5	

Sulpham contains 0.6% of Phelam (pheynl mercury dimethyl dithio carbamate) and 60% sulphur. Good results are reported in all treatments.

3. Insect Pests of Brassicas

Mr. A. D. Lowe at the 8th Lincoln College Farmers' Conference, 1958, reports on the effectiveness and cost of control of insect pests on brassicas. The following notes and table are compiled from his reprint.

Biological control

1 - Beneficial insects play a large part in the control of cabbage whites, diamond back moth and aphids.

2 - Insects' diseases play a large part in control.

3 - Warm weather builds up aphid attack and disease and rain reduces it.

Chemical Control

Spray	Pests Controlled	Rates per acre	Cost per acre	Remarks
Lindane	All	½ lb. 100% matl.	15/- to 20/-	
DDT	Cabbage whites, Diamond Back, Grass grub	½ to 1 lb. p.p.i.	10/- to 20/-	
Aldrin	Grasshoppers	4 ozs. 100% matl.	7/-	
Metasystox	Aphids	16 fl. ozs of 50% matl.	27/-	Systomic, giving superior control of aphids.

4. Aircraft Application of Fertilizer and Pesticide

The following is from the First International Agricultural Aviation Congress. Cranfield, England. September, 1959.

Fisons Pest Control Limited are agricultural contractors, and have been concerned with aerial spraying since 1947. It has been found that British agricultural conditions bring problems of drift danger, obstructions, relatively small fields, a short main crop season of potato blight control and uncertain weather. These all affect costs, but high crop values per acre offset them to some extent.

A permanent ground organisation (a contractor or a merchant) is essential in Britain for aerial spraying work and this accounts for a significant part of total costs. Fixed and variable flying costs have to be met; normally the operator requires a minimum guarantee, offset against acreage charges. For the future, some way may have to be found to relieve the ground contractor or merchant of part of this burden of guarantees.

Helicopters are, we find, the most economic type for many jobs here, but the fixed wing aircraft have a very definite place, depending on local conditions.

Aerial spraying has a future in Great Britain for an increasing number of operations, but there were too many aircraft available in 1959 for the work available.

In future the fleet will have to be somewhat reduced or more employed overseas to be economic and provide a sound service for the farmer.

5. Weed Control

Hamilton Lake was cleared of oxygen weed *(Anacharis canadensis)* by using a sodium arsenite solution. A commercial product "Penite 6x" was used containing 71.5% of sodium arsenite. A helicopter was used to treat the 140 acres of water and a final concentration of 10 parts As_2O_3 per million was aimed at. The total cost was £2,958 or just over £21 per acre. No harm was done to bird life but some dead pests were found.

(Service Vol. 4. No. 4. Winter 1960 p.4 - 6)

6. Tsetse Fly Control

(a) **East Africa** (See page 107). The cheapest and most successful operation so far was the use of dieldrin 2½% solution in oil over the north block at Chungai, Central Tanganyika, 0.125 gal per acre eight times from an Auster J5G aircraft. Costs over the grounds were £301 per square mile and incidental costs due to locality were £66 per square mile.

(Colonial Pesticides Research Unit, Arusha. Miscellaneous Report No. 263.)

(b) **Kenya** (see page 54). In the Kuja - Migori scheme started in 1955, the work was so successful that a plan has been drawn up for the complete extermination of the fly from the colony. A thousand square miles had been rendered fly-free, by means of spraying 755 miles of river and lake banks, at a cost of about £66 per mile. The fly-free area works out at about £50, per square mile.

Annual Report of the Veterinary Department (Kenya) for 1959.

7. Forest Protection, Tanganyika

The cost of maintaining electric fences against large animals, elephant, pig and buck, was considered to be high, £7 per mile in the Northern province.

(See page 65).

8. Economics of Filariasis Control in Fiji

Mr. G. F. Burnett's report on Filariasis research in Fiji (this issue of PANS, p.108) compares this sort of control by means of drugs and insecticides. The cost of drug administration programme was estimated to be one fifth of the cost of the house spraying programme.

The Insecticide Treatment

Report No. TR/1/2/4/58. 3 Dec. 1957.

Estimated Cost of Experiment at Ovaleu

Population of 2,825 people - i.e. about 600 huts etc.

	£
½ ton of dieldrin 50% wettable powder @ £1,042 per ton (60 mg/sq. ft.)	521
Staff - per year	558
Travelling and subsistence	288
Coast movement	8
Incidentals	125
Supervision	50
	£1,550

Cost per person protected 11/- (approx.) or £5-10-0 over ten years.

Cost of Drug Treatment (diethylcarbamazine).

G. F. Burnett - Filariasis Research in Fiji, 1957-59.
Colonial Pesticides Research Unit Arusha.

	£
per 1,000 people	
Drugs	40
Salaries, administration, sampling blood, examination of blood	667
Subsistence	154
	£861

That is just over 17/- per person, a figure considerably below the cost of insecticide elimination. Mr. Burnett points out that if the aims were to eliminate clinical filariasis and wait for filaraemia to die out the existing organisation of dispensaries could be used when the overall cost could be as low as £80 per 1,000 (1/6 per person) including a 10% survey before and after treatment. The drug under consideration is diethylcarbamazine citrate.

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Mode of Action of Insecticides

An investigation into physical factors affecting the toxicity of DDT solutions after injection into the haemolymph has been carried out. The effects of viscosity, relative solubility of the solvents for DDT and degree of dispersion in the haemolymph have been studied, using a range of formulations injected into the blowfly *Phormia terraenovae*.

Each formulation was tested over a range of concentrations and control experiments on the toxicity of solvent alone were carried out. The volume injected was 0.4 microlitres per fly in every experiment.

General conclusions: The 24-hour median lethal dose was found to be relatively unaffected by differences in formulation or solvent properties; this result contrasts with the known effects of varying the formulation of insecticide applied externally.

Though the ultimate effects of varying the formulation were negligible, significant differences in the rate of intoxication during the two or three hours following the injection were found.

Viscosity: The effects of viscosity were examined by comparing the straight chain aliphatic hydrocarbons, hexane, decane, hexadecane, P31 and P33 oils. The rate at which symptoms of intoxication appeared was slower for more viscous oils.

Dispersion in the haemolymph: (a) Differences in the rate of intoxication associated with viscosity disappeared if the oils were emulsified before injection.

(b) Solutions in water miscible solvents (glycols, ethyl alcohol and acetones) produce colloidal dispersions of DDT when injected. These dispersions produced very high percentages of knockdown almost immediately; typically, with concentrations substantially less than the median lethal concentration, 60 to 100% of the flies were knocked down within 3 minutes. The flies recovered over a period of up to 45 hours.

This rapid but reversible intoxication is not observed with DDT-solutions in solvents immiscible with water.

Solubility effects: The effect of varying the percentage saturation or "chemical potential" was investigated by injecting solutions of DDT in several aliphatic esters, which varied in their capacity to hold DDT in solution. Two aromatic hydrocarbons, (benzene and toluene) having different DDT-solubilities were also compared as emulsions.

Small differences in the rates of intoxication were obtained but it was not possible to relate these differences to the different saturation levels of DDT.

Biochemical studies

The results reported in April 1960 concerning insect cholinesterases have been confirmed by the experiments carried out in the last six months. It has been found possible to extract from a single homogenate of adult housefly heads, *M.domestica*, by differential centrifugation, a "cell debris fraction" containing an enzyme inhibited by the specific mammalian pseudocholinesterase inhibitor, tetra iso-propylpyrophosphoramide (iso-OMPA, at 10^{-4}M), and which is activated as much as 40-50% by the addition of dieldrin at a final concentration of 10^{-3}M. From the same homogenate a "mitochondrial fraction" was obtained containing enzymes unaffected by iso-OMPA but inhibited by 1:5-bis-(4-trimethyl-ammonium-phenyl) pentane-3-one di-iodide, (62-c-47). This enzyme is inhibited by 10^{-3}M dieldrin. The behaviour of the above two fractions to inhibitors and dieldrin was the same for dieldrin-susceptible and resistant flies. A "supernatant fraction" was also obtained which in susceptible flies is unaffected by iso-OMPA but is strongly inhibited by 62-c-47 and this therefore only contains one of these two enzymes. However the same centrifugal procedure on resistant flies produced a supernatant fraction inhibited 7-15% by iso-OMPA, the rest of its cholinesterase activity being largely due to the presence of true acetylcholinesterase.

It seems that these results are capable of two interpretations. Either there are two cholinesterases present corresponding to mammalian pseudocholinesterase and true acetylcholinesterase *or* one enzyme is behaving in two distinct and opposing ways dependent, presumably, on its association with other cell particles or structures. If this latter supposition is correct, it would throw much doubt on the characterisation of many enzymes by specific inhibition, and since such characterisation is well established, this is unlikely.

Experiments were also carried out on dieldrin susceptible adult houseflies *Musca domestica* to determine the effect of chlorinated hydrocarbon insecticides on enzymes synthesising acetylcholine.

In insects, acetylcholine is synthesised from acetyl coenzyme A and choline by choline acetylase. Smallman (1956) has also shown that in the blowfly *Lucilia sericata* two pathways are available for the synthesis of acetyl coenzyme A, namely, from acetate by acetylkinase and from citrate by means of the condensing enzyme working in reverse to produce acetyl coenzyme A and oxaloacetate. Our results show that in *M. domestica* as in some mammals (guinea pigs Smallman, 1956) but unlike *L. sericata* (Smallman, 1956) acetycholine can be synthesised equally rapidly from acetate and from citrate and thus that in this insect both pathways for the synthesis of acetyl coenzyme A (and thus acetylcholine) are equally available. The results also show that chlorinated hydrocarbon insecticides have no effect on the action of insect acetylkinase, condensing enzyme and choline acetylase.

Chemical Senses

The development of techniques for further work on chemoreception in bloodsucking flies is proceeding. This work includes the adaptations of a flame-ionisation detector for monitoring very small concentrations of organic stimulants in moving-air olfactometers.

COLONIAL PESTICIDES RESEARCH UNIT, ARUSHA, TANGANYIKA

PROGRESS REPORT NO. 27, APRIL - SEPTEMBER, 1960. (Interim Report 1960/1)

INSECTICIDES

Tsetse:

Field Experiments, Chungai: When allowance is made for the rise in control catches the total reduction in the two species has been 99.49% *(G. morsitans)* and 98.6% *(G. pallidipes)*. Immigration has doubtless reduced the apparent kill, which corresponds to a theoretical mean kill per application of 65% and 45% respectively. Much higher kills of males were recorded (see annual report for 1959-60). The discrepancy may be due to the much lower susceptibility of pregnant female *G. morsitans* to dieldrin rather than to immigration.

Much settlement has taken place in the block which now contains several hundred head of cattle and is no longer suitable for experimental work.

It is apparent however that where the demand for land is strong enough it may be disinfested sufficiently for settlement at a cost of about £300 per square mile, plus a variable amount due to the exact locality of the work. This experiment is more fully described in miscellaneous report No. 263.

Laboratory Work

Topical Applications of Insecticides: Work on topical applications has continued; in particular the effects of age and pregnancy have been investigated but the results are not yet complete; work is slow because relatively few flies survive even in the laboratory for three to four weeks and only a proportion of these do not abort. In addition, considerable batch variation has appeared and every result has to be checked with a standard insecticide (dieldrin). This uses up many flies.

Some results comparing DDT, gamma-BHC and dieldrin are tabulated below:

G. morsitans	*DDT*	*Wt*	*gamma-BHC*	*Wt*	*Dieldrin*	*Wt*
L.D.50 young males	.0165	32.6	.0030	26.6	.00075 (1) .0017 (2)	26.6 30.1
Young females	.025	36.8	.0036	34.8	.0010 (1)	34.8
Old females					.0047 (2)	41.36
Pregnant females					c.02 (2)	54.8
L.D.95 Young males	.085	32.6	.0085	26.6	.003 (1) .0051 (2)	26.6 30.1
Young females	0.17	36.8	.0087	34.8	.0054 (1)	34.8
Old females					.024 (2)	41.36
G. swynnertoni						
L.D.50 Wild males	.0065	28.7	.0026	32.1		
L.D.95 " "	.031	28.7	.0082	32.1		

(1) The numbers in brackets refer to flies from two different batches of pupae.

(2) Dosages in micrograms per fly.

Some other insecticides have been tested in a search for anything better than dieldrin. To economise on insects and at the same time allow for batch variations, the candidate insecticide has been tested at one or two concentrations simultaneously with dieldrin (it is assumed that the slope of the dieldrin regression line is constant) in fact all regression lines so far determined with this insecticide and *G. morsitans* have been parallel).

To date, aldrin appears to be considerably less toxic, endrin equitoxic and the new Shell insecticide WL. 1650 three to four times as toxic as dieldrin to young males.

A trial with a non-volatile solvent (Risella 117 kindly supplied by the Shell Company) showed that with dieldrin and gamma-BHC at about the LC50, final kill was identical but that the Risella solutions tended to kill more slowly. So far the slope of regression lines has not been determined. The solvents used in our serial experiments are all lethal as .02 microlitre drops and cannot be used in these experiments for this reason.

A comparison has been made between aldrin and dieldrin when applied in Risella 917 as 0.2 microlitre drops to the thorax and when used to impregnate filter paper. In both circumstances dieldrin was more effective and economical but the relative toxicity was different in each case. Details are given in Misc. Rep. 275.

Mosquitoes

Taveta-Pare Malaria Eradication Scheme: This Unit has continued entomological observations in the Taveta area following cessation of dieldrin spraying at the end of the Taveta-Pare Malaria Scheme.

The numbers of *A. gambiae* in untreated huts, as shown by spray catches, were greater than in the same months before residual spraying. The numbers in treated huts were of the order of thirty times greater than during the last year of residual spraying, but they were lower than in untreated huts by about 60%.

It is concluded that during the last six months, which includes the main transmission season, the continued absence of the erstwhile chief vector *A. funestus* (type), the high residual toxicity of a large proportion of the huts, and anti-malarial drug administration by the E.A. Malaria Institute in combination greatly moderated the return of malaria transmission in Taveta area.

Persistence of New Insecticides on Mud-Panels: Bio-assays on mud panels, prepared in a Uniport "Altent" at the Arusha Laboratory, were made to study the performance of the new insecticides on different types of mud surfaces. Three-day old blood-fed *A. gambiae* were used as test insects. Observations at weekly intervals for 22 weeks have shown that "Baytex", at 2 gms per square metre, gives high kills at eight hours exposure on a non-sorptive mud for three months and for two months on a sorptive mud. No kills attributable to the insecticide occurred at 15 weeks on non-sorptive and 10 weeks on sorptive mud. Malathion, at the same dosage, gave high kills at twelve hours exposure on non-sorptive mud. Mortalities approaching control levels appeared after 22 weeks for non-sorptive mud and 21 weeks for sorptive mud. Thus "Baytex", gave considerably higher kills than malathion for two months but its toxicity rapidly decreased, whereas malathion toxicity persisted so that after four months it was giving higher kills than "Baytex" at twelve hours exposure.

The effect of limewash was studied on the performance of the insecticide. The limewash was made up a few days before application and then applied a week before treatment by the insecticide. By this means, a limewashed wall was prepared that resembled the weather surface of an average limewashed building. The toxicity of "Baytex", at 2 gms per metre, was considerably greater and more persistent on the limewashed sorptive mud than on the sorptive mud alone. Malathion gave slightly higher kills on limewashed sorptive mud than on sorptive mud alone, but gave higher kills on non-sorptive mud than on limewashed non-sorptive mud.

Experimental Huts at Magugu: The new insecticides were applied by means of an Oxford Precision Sprayer with the exception of two walls of each hut which were treated by the Poulton "precision wall sprayer" (see Miscellaneous report No. 272) to provide even deposits for bio-assays.

For "Baytex", the mean deposit per hut, as determined by chemical analyses of filter papers exposed at the time of spraying was 0.8 gms per square metre between the limits of 0.68 and 0.88 for individual huts. Similarly, the walls used for bio-assays averaged 1.2 g per square metre between limits of 0.92 and 1.36. The mean deposit of malathion was 1.33 g per square metre between limits of 1.27 and 1.46. The walls used for bio-assays averaged 1.83 g per square metre between limits of 1.6 and 2.19.

The results shown in the accompanying table, indicate that "Baytex" and malathion satisfy the W.H.O. specification for a residual insecticide i.e. a minimum mortality of 75% after two months.

Percentage mortality of naturally entering *A. gambiae* in experimental huts

Type of wall	Age of deposit in weeks										
	1	2	3	4	5	6	7	8	9	10	11-15
BAYTEX											
Limewash sorptive	100	100	100	100	100	77	79	75	71	60	25
Sorptive	100	99	100	100	95	93	98	96	100	100	100
Limewash non-sorptive	100	100	100	100	100	91	90	84	64	67	73
Non-sorptive	100	100	100	100	89	86	100	80	100	100	50
Plywood	100	100	100	100	96	97	96	100	96	100	71
MALATHION											
Limewashed sorptive	100	99	80	100	96	83	88	76	86	75	77
Sorptive	100	100	99	100	100	100	100	100	100	100	100
Limewash non-sorptive	100	97	92	100	92	94	95	100	100	100	-
Non-sorptive	100	96	97	93	82	86	85	75	100	92	88
Plywood	100	100	96	100	93	92	94	100	94	75	78
B.H.C. - CERECLOR	(Two years plus the following weeks)										
Sorptive	-	12	20	30	7	21	35	48	36	18	71
UNTREATED											
Non-sorptive	4	13	5	12	0	0	9	10	4	17	0
Non-sorptive	5	27	6	4	0	1	1	5	14	18	13

Bio-assays showed that the toxicity of "Baytex" and of malathion was greater on the grass roofs than on the mud-lined walls, and indicated that the roofs were responsible for a high proportion of the kills of naturally-entering *A. gambiae*. Plywood wall surfaces gave similar mortalities to those of grass roofs.

BHC - Cereclor continues to give mortalities approaching 100% with exposures of 30 minutes duration on the walls and of three hours on the roof. These results are of interest because of the low mortalities that occur among naturally entering *A. gambiae* (see Table 4). This discrepancy between bio-assays and overall mortalities is being investigated further by observing the behaviour and assessing the mortalities of a known number of mosquitoes released into the treated huts.

Design of Huts, Magugu: So far, numbers entering the hut seem to be about the same as in African houses and preliminary catches show that in these huts with wide open eaves through which much light enters only about 10% of the mosquitoes leaving are caught in the window traps. Reducing the size of the gap at the eaves from 6 inches to 2 inches has had no effect. Further reduction to 1 inch appeared to have effect and it was intended to check this by returning to the 2 inch gap. Unfortunately, *Anopheles gambiae* almost disappeared at this juncture, but *A. funestus* increased and observations will have to be repeated on this species.

Vulnerability of *A. gambiae:* Studies were continued on the distribution of resting *A. gambiae* and on its movements in huts in the Umbugwe area. Hand catches in eight untreated experimental huts showed that 21% of 1,549 *A. gambiae* rested on the walls at night: this proportion can be compared with 10% resting on the walls during the daytime (See Annual Report 1959/60). It is thus concluded that the roofs are the most important resting places in the experimental huts. This finding supports the bio-assay results which indicate that the roofs are chiefly responsible for the kills of naturally entering *A. gambiae* in "Baytex" and malathion treated huts.

A further study during the dry season, when naturally-entering *A. gambiae* were present in negligible numbers, was promoted by releasing a known number of blood-fed mosquitoes into untreated and insecticide-treated huts.

This study thus provides some confirmation. It transpired that about 60% of the blood-fed *A. gambiae* leave the experimental huts by the eaves.

Susceptibility of *A. gambiae:* At Magugu the monthly visits to measure the susceptibility of *A. gambiae* to DDT, dieldrin and gamma-BHC were continued up to June, so that 16 monthly visits have been made including two long rainy seasons. There appears to be a direct correlation between rainfall and susceptibility to the three insecticides. A report on this is being written.

Pseudotheraptus on Coconuts:

At Kidichi the spraying of the 100 acre block with the L.A.M.B. sprayer continues. Difficulties have been experienced with weather and machine and the vidaka damage rate (v.d.r.) rose above the 15% level from mid-March to mid-July despite sprayings in March and May to June. In early July an entirely successful treatment reduced v.d.r. to 2% and by mid-September it was still only 7% despite a rise in control v.d.r. A recent comparison of the L.A.M.B. and an aircraft spray (Misc. Rep. No. 276) makes it clear that adequate coverage among the tall palms at Kidichi is probably at the limit of the capacity of the ground machine and if any one of a number of factors (e.g. machine performance, weather, insecticide concentration) is below optimum the effect is likely to be a marked reduction in efficacy.

So far, there has not been time for the effect of cultivation to be reflected in yield from the selected plots. It is noticeable that the v.d.r. from one particular plot (No. 8) has always been much higher than the others or from the random collections (36.8% compared with 10.5% for the total experimental plots for the period 22/7 - 15/9/60.) The *Oecophylla* infestation rate is much the same. From the Kidichi sprayed area as a whole the yield has exceeded that from the control for the second and third pickings of 1960. The yield per palm, for the second picking at least, was less than in the control (16.4 versus 17.5). Spadix counts have so far shown that more nuts are produced per spadix in the treated area than in the control plots and in both plots cultivation increased the number. In the control plots several spacides have shed all their nuts.

Cultivation has not so far reduced the percentage of palms harbouring *Oecophylla*.

Biting Fly Research, Uganda

Laboratory Work: It had long been suspected that under field conditions *S. calcitrans* pupae undergo diapause. Laboratory work has shown that this is not due to changes in relative humidity affecting the pupae but a preliminary trial, now being followed up, suggests that diapause is determined by conditions to which the 3rd stage larva is exposed.

In a laboratory test it was found that a dieldrin emulsion, as used in tsetse control work, was very much more persistent to rain on vegetation than the chlordane emulsion hitherto used in the *Stomoxys* work.

Field Work: Fly rounds were continued at Koja where the bionomics of *Stomoxys* spp. in natural mixed farming conditions is being studied. Fly populations in both Mutaba II (experimental area) and Sabaddu (control) reached maximum in April - May following the two months of maximum rainfall. To simplify analysis of the results of control measures it was decided to divide Mutuba into two parts, treating one and using the other as a control. Spraying has been done twice, on 27-28th June and 7-8th September using 'Dieldrex 15' diluted to 3.4% applied to the 50 kraals. (Owing to a shortage 10 kraals could not be sprayed until September 28th.) Catches in the sprayed area fell and have remained considerably below those in the control, which have also fallen.

FUNGICIDES

East Africa

A trial was carried out in March 1960, in co-operation with the staff of the Jacaranda Coffee Research Station, Kenya. Equivalent quantities of copper were applied to multiple stem coffee with 7, 60 or 120 gallons of water per acre using Whirlwind Knapsack mist blowers.

Estimations of subsequent copper deposits on leaves and filter papers showed that whilst increasing the amount of water used improved the coverage obtained and the amount of spray arriving at the targets, the wastage of copper, due to run-off, increased at a still greater rate. Thus, the amount of copper remaining on the tree was greatest with the low volume application and least with the high volumes. Count of the subsequent rust infections showed all three treatments highly effective. Details of the physical assessments have been given in Misc. Report No. 269 and details of the biological work are to be published by Jacaranda.

A modified trail based on these results is being carried out in co-operation with the Lyamungu Coffee Research Station, Tanganyika. This trial which is still in its early stages, appears to confirm the Jacaranda results in that the largest deposits of copper seem to be obtained by using the least volume of water when using hand machines. It also appears that the amount of wastage is also affected to a lesser extent by the copper concentration in the spray i.e. the higher the copper content of the spray, the more wetting agent present, the greater the run-off. Results of this trial will be published as soon as they are available.

As a continuation of this work on the effect of the amount of water used to apply given amount of fungicide to coffee a further trial has been carried out in co-operation with the staff of the Jacaranda Research Station, using a large tractor-mounted mist-blower. The results of this trial have not been fully analysed yet but do suggest that the results with these large machines may be on a different scale from the small man-carried mist blowers reported in the Misc. Report No. 269. There seemed little change in the relative efficiency with which the copper was deposited when the amount of liquid used in the large machine was varied between 10 and 85 gallons per acre. This suggests that these machines gave much more even coverage and there was little or no wastage due to run-off even at 85 gallons per acre. By contrast it is very difficult to treat a tree really evenly with hand-operated machine and localised run-off with consequent wastage can occur with much smaller volumes of water per acre.

West Africa

An artificial-rain tower has been constructed, with which 20" per hour of rain in drops of about 0.7 cm diameter falling at approximate ½ terminal velocity can be applied to cocoa pods previously treated with fungicide. The rate of removal of the deposit, determined chemically, with increasing rainfall has been studied for a wide range of fomulations. Providing the deposit was allowed to dry before application of rain, the majority of formulations tested showed high tenacity; 32" rainfall removing approximately one half of the initial deposit. The surface tension of the various fungicide formulations diluted to working concentrations has been determined, using a Du Nuoy balance.

Further investigations of the direct toxicity of copper compounds to zoospores by a mixed suspension technique showed that there was no great difference between the mean lethal concentrations (determined as copper) for cuprous oxide and copper oxychloride, for particles of the same size range. The toxicity of both compounds was inversely related to particle size.

Two field trials have been set up at the W.A.C.R.I. Gambari Experimental Station near Ibadan. The first has seven treatments as follows:

1. Perenox; cuprous oxide W.P. (50% Cu), at 0.4% w/v aq. suspension.

2. Oleocuivre; cuprous oxide/emulsifiable oil suspension (40% Cu), at 0.5% aq. suspension.

3. Coprantol; copper oxychloride W.P. (50% Cu), at 0.4% w/v aq. suspension.

4. Copromat; copper oxychloride +ziram W.P. (54% c.o.c. + 32% ziram) at 0.4% w/v aq. suspension.

5. Mercurised Brunostani copper oxychloride + mercurial (50% Cu + 0.6% Hg.) at 0.4% aq. suspension.

6. Bordeaux mixture 10: 4 mixture $CuSO_4$ $5H_2O$ and CaO as 0.4% Cu w/v aq. suspension.

7. Untreated control.

With this range of formulations it was anticipated from previous laboratory studies that a range of effectiveness would result. Various formulation innovations would also be directly compared. Current results appear to agree with expectations.

The second has treatments:

1. (1% so called) Carbide Bordeaux mixture.

2. An equivalent Bordeaux mixture in which lime replaces the calcium carbide. (This is the same as treatment 6 above.)

3. Bordeaux mixture at 2 x concentration but applied only 6-weekly as compared with the recommended 3-weekly used for the other treatments.

4. Untreated control.

These treatments are designed directly to compare lime and carbide Bordeaux mixtures, since it is possible that good lime will become more freely available in Nigeria in the future, and also includes a possible variation in the frequency of spraying.

MOLLUSCICIDES

Most of the molluscicides work is being conducted on a large sugar estate at Arusha Chini where both *A. haematobium* and *S. mansoni* are endemic. The sugar company concerned (The Tanganyika Planting Company) has been spending sh. 20,000 annually on sodium pentachlorophenate and copper sulphate without achieving much control of snails. It has been estimated that at least 70% of the labour force of 4,000 workers suffer from bilharzia. The estate is thus an excellent area for the molluscicides work especially since the company is able to afford much assistance with irrigation engineering and medical problems.

Field Trials for Assessing the Efficacy of Compounds which are Beyond the Primary Screening Stage: One of the most important requirements in any programme concerned with testing the efficacy of molluscicides in the field is a reliable means of assessing mortality rates and it is to this end that the work has initially been directed. Bamboo rafts have been used for this purpose but for several reasons are unsatisfactory. Another method depends upon confining snails in cages at various stations within the experimental area. Whilst this latter method may enable a satisfactory statistical design to be planned for molluscicide trials the effect in the artificial habitat in the cages may not be comparable to that in natural habitats.

The method has been employed in a trial with the new molluscicide I.C.I. 24223 (isobutyltriphenylmethylamine). The irrigation channel selected for the trial was fed from a reservoir and during the trial was flowing at a rate of 1½ cusecs. The mean surface velocity of the water during the trial was approx. 1 foot/sec. and the water temperature 22°C - 25°C. The bottom of the channel consisted of thick silt with little or no aquatic vegetation.

The molluscicide, being formulated as a 94% dispersible powder, was applied via the apparatus designed by Foster and Poulton (Bull. W.H.O. (1959) *22* 549-554). 1 part in 500 of "Lissapol" was added as a wetting agent. The application was made at the point where the channel was fed from the reservoir, there being a drop of about two feet, thus ensuring adequate mixing. The dose employed was 0.75 ppm. for 8 hours.

Two series of mud samples were taken at 20 yard intervals from the culvert head at the reservoir to a point 1,060 yards downstream. The first of these series of samples was taken ten days before treatment and the second series seven days after treatment. From observation and analysis of the sampling data the following results were obtained:-

(a) All egg clusters were destroyed.

(b) Probably all tadpoles and fish were killed.

(c) *Biomphalaria* - 100% mortality.

(d) *Bulinus* - 95% mortality.

(e) *Melanoides* - 60% mortality.

(f) There was no observable effect on plant life.

Higher mortality figures were obtained for the vector species of bilharzia *(Bulinus* and *Biomphalaria)* than for the operculate snail *Melanoides*. *Lymnaea* and the operculate snail *Cleopatra* were also present, but in insufficient numbers to assess mortality rates.

Although the results need confirmation by further experiments a means is provided for assessing the mortality rates of the different species of snails and also of assessing the distribution of snails in the treated area before and after application of molluscicides. Similar trials are planned modifying the method to ensure more accurate assessments and to include a number of snails in cages as a basis of comparison.

The work in irrigation systems is complicated by the alteration of the habitat caused by drying up or cleaning of the canals during irrigation. In order to overcome these difficulties it is planned to construct a number of similar channels and reservoirs which can be used exclusively for molluscicides trials. When these are completed it should be possible to run simultaneous and parallel trials with various molluscicides at different concentrations.

A Pilot Bilharzia Control Scheme: A pilot bilharzia control scheme has been initiated at Arusha Chini. The following species of snails have been recorded from the irrigation system:- *Biomphalaria pfeifferi nairobiensis, Bulinus tropicus, Lymnaea caillaudi, Cleopatra ferruginea, Melanoides tuberculata tuberculata.* Snail collections and sampling are being carried out to determine the distribution of the snails, population densities in different habitats and infection rates of the vector snails. Clinical studies by the medical department of The Tanganyika Planting Company are aimed at assessing the incidence of bilharzia in the area. When these preliminary studies are complete an attempt will be made to eradicate the vector snails throughout the irrigation system by the use of molluscicides. It should then be possible to estimate the effect of molluscicidlng on the incidence of bilharzia in the area.

Field Trial with Bayer 73 at Mwea-Tebere, Kenya: The experimental date for the trial at Mwea-Tebere, carried out in September, 1959, have been examined and are reported in Misc. Report No. 273.

HERBICIDES

Control experiments are being carried out on the woody weeds, *Lippia ukambensis* and *Aspilia asperifolia* and the Sodom Apple *(Solanum incanum)*; the herbaceous species *Cyperus rotundus, Oxalis* spp. and *Argemone mexicana;* and on certain water weeds.

Weed control investigations have been made on the following crops: coffee, pyrethrum, maize, dwarf french beans and cotton.

Other projects include a weed competition trial and the persistence of herbicides in the soil.

PHYSICS SECTION

Aerial Spraying Equipment: In February, a D.H. Beaver aircraft from Desert Locust Control was assessed at C.P.R.U. The aircraft was fitted with Britten-Norman Micronair spraying equipment, replacing the boom and nozzle spray gear previously used. A useful relationship between the peripheral speeds of the spinning cages and the M.V.D. of the droplets, was deduced for various emission rates. It was shown that peripheral speeds of the cages decreased with increased emission rates, and since the peripheral speed is the fundamental drop forming factor, the emission rate provides a useful control of droplet size. See Miscellaneous Report No. 258.

Use in Wheat Rust Control: In June, an experimental spraying trial with the Auster Aircraft was carried out at Ol Molog in an effort to control wheat rust. The fungicide used was "Pesco Zineb" made up as a 10% w/w suspension in water. There was no effective control of rust in the wheat at all, but further trials are planned later in the year with the co-operation of the Pathologist of the Kenya Agriculture Department.

Droplet Assessment: Magnesium-oxide-coated plates are unsuitable for the sampling of sprays of aqueous media, because the droplets tend to skid and sink into the magnesium oxide powder. Alternative sampling techniques have been investigated and Yeo has successfully used fixed photographic paper.

CHEMISTRY SECTION

Bio and Chemical Assay Discrepancies: Analysis of mud scrapings from whitewashed mud in the experimental huts at Magugu indicated that no malathion was present in a quarter of an inch scraping 15 weeks after spraying. Bio-assay showed, however, that some insecticide was still available.

"Baytex" was detected on all mud surfaces in the Magugu huts 12 weeks after spraying.

Analysis of scrapings from the wall panels sprayed at Arusha showed that approximately 50% of the "Baytex" sprayed onto Magugu block mud panels still remained after 20 weeks. Bio-assay indicated that the insecticide was not biologically available.

Persistence of Dieldrin on Non-Sorptive Surfaces in Houses: It was found in Fiji (Burnett 1960. J. trop. Med. Hyg. *43* (9)) that when dieldrin emulsion was applied to the inside of the houses heavier deposits were disproportionally persistent when chemically assessed. It appeared that this might be due to the saturation of the air in the houses with dieldrin vapour. A small experiment to check this has been set up in some unused huts at Magugu.

Results to date confirm the original findings and support the conclusions drawn.

A total of 1,488 samples have been handled in the chemical laboratory. These include numerous copper estimations from coffee spraying, malathion content in stored maize from Mombasa, and BHC content of cooked maize meal from Scott Agricultural Labs. Nairobi; insecticide sample papers and wall scrapings, leaf samples from Biting Fly Research Entebbe, analysis of commercial formulations and spray solutions used in aerial and ground spraying of coconuts in Zanzibar.

COLONIAL PESTICIDES RESEARCH UNIT, PORTON
HALF YEARLY PROGRESS REPORT, 30th SEPTEMBER, 1960

CPRU/Porton/Report No. 179

Esterases Studies on Mosquitoes

Work on the properties of esterases in mosquitoes has continued. Previously histochemical methods have shown that the acetyl cholinesterase activity in the ganglia of head and thorax is greatly reduced in insects which have been treated with lethal doses of organo-phosphorus compounds. This reduction has now been confirmed by the determination of enzyme activity in homogenates of poisoned mosquitoes. It is significant that inhibition of esterase activity in a particular mosquito species only occurs after the application of a given insecticide at a dosage which is toxic to that species. Consequently there appears to be a close connection between the toxicity of organo-phosphorus compounds and their enzyme-inhibitory powers.

Experiments with Granules for Maize Treatment

Rate of Break-up

Attapulgite granules are obtainable in two forms with different rates of disintegration, namely the quick breaking "AA" RVM (regular volatile material), and the slow breaking "A" LVM (low volatile material). The rate of break-up in water has been examined by shaking between filter papers to stimulate the conditions within the whorl of a maize plant.

Results so far indicate that the amount of material resulting from the break-up of RVM granules that passes an 85 B.S. sieve increases up to a maximum of about four times the amount from LVM granules. This is after shaking for three hours at 300 vibrations/minute, probably equivalent to the constant vibration of a maize plant for more than 30 hours.

Means of Distribution

The characteristics of a commercial hand-operated granule distributor, the Cook "Granula", have been determined. The rate of output and type of distribution obtained with 30/60 T.S.S. granules as used for control of maize stalk borer have been found and are given in full in CPRU/Porton/Report No. 176. The size and number analysis of the granules in B.S.S. terms is also given.

Retention by Maize Plants

A study similar to that carried out on the retention of sprays by maize plants (see CPRU/Porton/Report No. 169) has shown that slightly more granules are retained initially by wet plants than by dry plants. On wet plants the proportion of granules retained by the leaves to that in the whorl is 2:1, whereas on dry plants the proportion is 1:3. If the wet plant dries and is shaken as if by wind the proportion on leaves and whorl is 1: 1.3.

The effect of rain on the distribution of granules on a dry plant is to change the proportion on leaves and whorl from 1:3 to 1:13 without significantly removing them from the plant. The details are given in CPRU/Porton/Report No. 178.

Application of Pesticides from Aircraft

The final results differ only in one respect from those reported earlier, (see PANS 'A' 1960 6 (4), 478). When account is taken of the relative collection efficiencies of the sampling devices on the ground, and the absolute collection efficiency of the filter paper envelopes is taken as 100%, ground recovery of active agent, as determined by colorimetric estimation of dye residue on the glass sampling plates, is complete, within broad limits of experimental error, despite loss of solvent by evaporation which above 25 ft operating height approaches 50%. This is in accord with the almost complete absence of measurable aerial drift, when sampling with cascade impactors at a tower 180 yd downwind of the aircraft track.

The main distinction between the helicopter and the fixed-wing crop sprayer was noted when the helicopter was operated under conditions in which the spray was deposited primarily by inertial impaction in the airstream from the rotor, (which with the S.A.6, occurred below the limiting height/speed combination of 20 ft/30 m.p.h.). Due to local eddy effects, density distribution was less even than when deposition was due primarily to sedimentation, but crop penetration under the former conditions is likely to be increased due to intense disturbance of the foliage.

Variation in underleaf cover is currently being investigated in a continuation trials programme, using both rigid and flexible sampling devices, under a series of flying conditions which previous work has suggested will show up more clearly the distinction between inertial impaction deposition (droplets being deposited within the helicopter ground effect) and sedimentation deposition (height and speed such that drops are only weakly influenced by the ground effect).

Wind Tunnel Studies

The sampling efficiency of a coarse aerosol by vertical cylinders has been measured. It is found that the inertia process causes deposition similar to that predicted by computation for ideal flow, provided that the ratio of mean droplet diameter to cylinder diameter is less than about 0.025.

If this ratio is 0.025 the difference between total measured collection efficiency and computed inertial collection efficiency, exceeds the theoretical interception efficiency by about 50%.

A bearing-mounted spinning disc is being set up to provide a stable droplet source at higher tunnel wind velocities and lower disc speeds, so that larger droplets may be investigated more satisfactorily.

Assessment Techniques

Fluorescent Tracers

A number of proprietary fluorescent compounds have been obtained, and these have been examined with regard to their usefulness as tracers for quantitative measurements of very small volumes (10^{-4} cc. or less). The most sensitive materials so far examined have been members of the oil-soluble "Uvitex" series of compounds marketed by Messrs. CIBA, Clayton, Manchester. Several compounds have been obtained which permit laboratory concentration measurements to be made with an accuracy of about 2%, down to the low level of 10 µg per litre so that volumes of 10^{-4} cc. of 0.1% tracer are readily estimated. However, these ultra-sensitive compounds are not stable to sunlight, so that until this aspect has been fully investigated they cannot be considered reliable for field use.

Photographic Paper

Fixed glazed photographic bromide paper has been examined with regard to its potential usefulness as a sampling surface facilitating drop size measurements of insecticidal and other sprays. Drops of certain liquids sampled on the glazed surface form well-defined circular impressions or stains in the gelatin layer, of diameters which can be related to those of the impinging drops.

For a given liquid, the spread factor, i.e. the ratio of stain or impression diameter to droplet diameter, is not constant with varying size of droplet, being a function of droplet momentum at impact. Thus for greater accuracy in subsequent measurement, calibration conditions should match those of the sampling application in regard to droplet impact momentum.

A calibration for water droplets covering a wide range of size, and sampling under conditions such that impact velocities ranged between 2-8 m.p.h., yielded a linear relation of the form D = 0.50 (S) 0.91 when impression diameter (D) was plotted against stain dia. (S) on log-log graph paper. Maximum scatter over the range 0.02-2mm. corresponded to a deviation of 15% from the droplet diameter as predicted by the calibration line.

The method may be used satisfactorily with aqueous solutions, oil-in-water emulsions, and other liquids capable of penetrating the gelatine film, provided that the contact angle at the air/liquid/gelatin interface exceeds zero. In general, exceptions to the latter condition are liquids with low air/liquid surface tension, which wet the gelatin and spread irregularly to form thin films.

Full details of this work are given in CPRU/Porton/Report No. 177.

Collection Efficiency of Surfaces

Some laboratory experiments are in progress to assess the factors which determine the liquid load that an angled collecting surface can sustain up to and beyond "run off", when sprayed with droplet spectrums of various v.m.ds. from a hydraulic nozzle.

This work is to provide additional information relevant to the sampling devices being used in the current helicopter field trials, but is being extended to enable a comparison to be made with some leaf surfaces of interest.

THE EFFECT OF DIELDRIN TREATMENT ON THE SUSCEPTIBILITY OF ADULT *AEDES AEGYPTI*

W. R. BRANSBY-WILLIAMS. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Miscellaneous Report No. 260.

This study is of the resistance of *Aedes aegypti* to dieldrin. In successive generations, newly hatched *A. aegypti* adults, of both sexes, from the colony at Arusha, were exposed to different concentrations of dieldrin, using the technique described by Busvine and Nash (1953, 1954). The mortalities were counted after 24 hours and the LC50 values compared, using a normal Busvine/Nash technique.

Differences in mortality were caused by different temperatures during treatment. In the table given below it is not the actual values that are important for any generation, but the comparative values of the treated and the colony mosquitoes.

Never was this difference greater than three times and there was no indication of it rising to a peak or even remaining steady. It is considered that this difference was not due to the development of any resistance nor even "vigour tolerance", but to weaker adults from the colony arising from overcrowding of the larvae. There were never sufficient eggs from the treated strain to put as many into the same bowl as was normally done for the colony. For the F10 generation the number of the treated strain and the LC50 values for the two of them are very close. The results with males were too variable to draw any conclusions.

Comparative LC 50 values for generations of treated and colony *A. aegypti*, tested at the same time

Generation	LC 50 Females	LC 50 Males
F1	0.12	-
Colony	0.12	-
F2	0.64	0.42
Colony	0.49	0.27
F3	0.58	-
Colony	0.45	-
F4	0.27	0.12
Colony	0.12	0.05
F5	0.35	0.12
Colony	0.26	0.12
F6	0.25	-
Colony	0.22	-
F7	0.43	0.30
Colony	0.40	0.16
F8	2.0	0.23
Colony	0.7	0.27
F9	0.82	-
Colony	0.66	-
F10	0.60	-
Colony	0.58	-

A REPORT ON THE ADULT W.H.O. TEST KIT FOR BIOASSAY OF INSECTICIDE DEPOSITS ON WALL SURFACES

J. A. ARMSTRONG AND W. R. BRANSBY-WILLIAMS. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 222.

Wall exposure tests using the Conical Exposure Chamber, and the Dish Exposure Chamber, as supplied by the W.H.O., have been carried out twice weekly for a period of three months by this Unit. The purpose of the test series was to investigate, (a) the convenience of handling the two types of exposure chamber, (b) the consistency of results obtained when replicate exposures are made, (c) a comparison of the results obtained with the two types of exposure chamber when applied to the same type of wall surface, and (d) which of the two methods indicates the ageing of the insecticide deposited with the greater degree of accuracy.

To provide a wall surface on which to carry out the tests, a brick wall plastered with a sorbtive and a non-sorbtive mud was constructed in Arusha. The wall was built around the inside of a circular aluminium house (Uniport Altent). The wall 5' 9" (178 cm) high, about 20 feet (6 metres) long, was divided into two sections, one which was plastered with a sorbtive mud (from Babati near Magugu), and the other which was coated with a non-sorbtive mud (from Njoro Nkubwa near Taveta, see Burnett, Bull. ent. Res. 1957, Vol. 48).

The panels were sprayed with an Oxford Precision Sprayer fitted with a flat fan nozzle at a nozzle pressure of 30 lbs per square inch. For chemical analysis, three sample papers were affixed to each panel prior to the application of the insecticide. After the spray the papers were analysed by using the Stepanow reduction method for total chlorine estimation. The mean dosage on each panel was found to be; DDT on sorbtive mud 1.98 g per sq. metre, DDT on non-sorbtive mud 1.69 g per square metre; dieldrin on sorbtive mud 0.63 g per sq. metre, and on non-sorbtive mud, 0.59 g per sq. metre.

The test insects used were adult female *Anopheles gambiae* Giles, and adult female *Aedes aegypti*, each maintained as a colony at the laboratory. The *A. gambiae* colony originated from the East African Malaria Unit at Amani, the *A. aegypti* colony is a mixed strain which has been maintained at this Unit for several years. All tests were set up three hours after the blood meal. Whenever possible only three day old blood-fed female mosquitoes were used, unfortunately it was necessary at times to use mosquitoes as old as 5-6 days and gravid or unfed.

Conclusions

(a) The convenience of handling the two types of exposure chambers in the field.

Each chamber has its own advantages; with the Conical Exposure Chamber, the condition of the wall was not as important as with the Dish Exposure Chamber, but on a smooth wall the Dish Exposure Chamber was more convenient to use than the Conical Exposure Chamber.

(b) The consistency of results obtained when replicate exposures are made.

The main cause for the variations observed in these tests was the relatively small number of test insects used. If about 30 insects could be placed in each chamber results obtained would be much more consistent. The test insect used was another factor, *A. aegypti* were much more difficult to handle, especially in the Dish Exposure Chamber. When so many *A. aegypti* became trapped the number in the replicate, that could be transferred to the holding cage was frequently reduced by 30%.

(c) A comparison of results obtained with the two types of exposure when applied to the same type of wall surface.

When sufficient insects were tested in each type of chamber, there was no difference in the results obtained with the two types. It is considered that the results obtained with the two types are fully interchangeable.

(d) Which of the two methods indicate the ageing of insecticide deposits with the greater degree of accuracy.

As stated in section (e) there does not appear to be any difference between the two types of exposure chamber.

(e) The sorbtive character of the wall.

There was no rain for the duration of tests 1 to 12, and the fall off in efficiency of the insecticides shows up with both *A. aegypti* and *A. gambiae*. The rains which started about test 13 and continued till test 20 resulted in a higher kill on all wall surfaces, this was more noticeable where *A. gambiae* was used as the test insect. It has not been possible to explain the low kills that occurred in test 1, followed by the increase in mortality in test 2, in the tests with *A. aegypti*. The tests with *A. gambiae* illustrates the difference between the non-sorbtive and the sorbtive mud more clearly than the *A. aegypti* tests. The effect of the higher humidity in increasing the killing power of the insecticide on sorbtive mud was also shown more clearly with *A. gambiae*.

A. gambie exposed for 30 minutes to DDT and dieldrin sorbtive and non-sorbtive mud surfaces

(In the table are shown the percentage mortalities recorded)

	DDT				Dieldrin			
	Sorbtive Mud		Non-sorbtive Mud		Sorbtive Mud		Non-sorbtive Mud	
	Cone	Dish	Cone	Dish	Cone	Dish	Cone	Dish
Control	0	23.1	-	6.7	6.7	-	10	0
Replicate								
1	6.7	7.2	13.5	20.0	11.8	6.7	31.3	18.8
2	0	37.5	0	26.6	18.8	23.5	17.6	26.3
3	6.7	13.4	15.4	43.0	0	11.8	27.6	10.0
4	0	18.2	43.0	33.3	0	17.6	20.0	25.0
5	7.2	46.7	23.5	14.3	13.5	6.3	35.6	31.0
6	7.2	6.3	23.1	31.3	12.5	25.0	25.0	21.5
7	13.4	13.4	0	20.0	17.6	6.7	23.0	40.0
8	6.3	43.7	50.0	26.6	13.5	26.6	17.6	0
Average	5.8	24.5	22.1	17.0	11.0	15.6	24.5	21.3

TOPICAL APPLICATIONS OF INSECTICIDE TO TSETSE FLIES

I. DDT, DIELDRIN AND BHC TO YOUNG *GLOSSINA MORSITANS* WESTWOOD

G. F. BURNETT. Colonial Pesticides Research Unit, Arusha, Tanganyika. Arusha Miscellaneous Report No. 268. Sept. 1960.

A considerable amount of work has been done by this Unit in applying solutions of chlorinated hydrocarbon insecticides as aerosols to bush infested by *G. morsitans*, *G. swynnertoni* and *G. pallidipes*. Only the minimum necessary laboratory work could be done before these experiments were started but the results obtained were not inconsistent with laboratory findings. In 1959 aerial work restarted but the first experiment (using lindane) was a failure, the second, using dieldrin on the same block of bush, was a success. (Misc. Reports 236 and 263). It was clear that more laboratory work was needed to assist in explaining these results. Experiments have been made easier since 1948 by the availability of equipment capable of applying smaller drops than could be done then, and by the possibility of obtaining wild collected pupae of *G. morsitans* relatively in large numbers.

Summary

Solutions of pp' DDT, gamma BHC and dieldrin in oil have been applied as drops of .022 microlitres to the thoraces of *G. morsitans* adults 2-5 days after eclosion and on the day following the first blood meal. For routine work, solutions in lighting kerosene have been used but a check with an involatile oil, Shell Risella 117, showed a slower action but the same end result.

LD 50's with confidence limits have been calculated from regression lines; females tended to have higher LD 50's than males but significance was not reached. The regression lines for dieldrin and DDT and dieldrin and BHC were statistically parallel at $p = .05$, those for DDT and BHC were not. Dieldrin was the most potent insecticide, DDT the least. Two batches of tsetse tested nine months apart showed a 2-2½ times change in susceptibility to dieldrin and BHC but the effect of DDT was unchanged. Relative potencies at the LD 50 level were about 4 for dieldrin and gamma BHC, 2-7 for gamma BHC and DDT. At the LD 95 level this last ratio increased to 4-20.

TOPICAL APPLICATION OF INSECTICIDES TO TSETSE FLIES
II. ENDRIN, ALDRIN AND SHELL INSECTICIDE WL1650 TO YOUNG *G.MORSITANS*

G. F. BURNETT. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Miscellaneous Report No. 278.

Three hydrocarbon insecticides are compared with dieldrin when applied as drops of .02 µl in kerosene to young male *G.morsitans*. Endrin was found to be equitoxic with dieldrin, aldrin one eighth as toxic (95% F.L. .085 - .019) and Shell insecticide WL 1650 2½ to 3 times as toxic (95% F.L. 1.93 - 3.90).

AIRCRAFT APPLICATION OF INSECTICIDES IN EAST AFRICA
XIII. AN ECONOMIC METHOD FOR THE CONTROL OF *G.MORSITANS* WESTW.

G. F. BURNETT, D. YEO, A. W. D. MILLER and P. J. WHITE. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 263.

Summary

The north block at Chungai, about 11 square miles of thorn savannah and thicket in Central Tanganyika, was treated with an Auster J5G aircraft between July, 1959 and March, 1960, in an attempt to eradicate *G.morsitans* and *G.pallidipes*. Dieldrin in 2½% solution in oil was emitted at 0.125 gallons per acre, eight times at approximately 4 weekly intervals. Swathe width was 55 yards and the aircraft emitted as it flew in both directions over the block.

The operation suffered delays and three applications were incomplete to varying degrees. Kills of *G.morsitans* per application appeared to be over 90% for males and over 85% for females, but the final reduction of 99.52% could have been attained with consecutive mortalities of only 65%. It is suggested that this discrepancy may be due to the higher lethal dose required by pregnant females. *G.pallidipes* were reduced by nearly 99%. Numbers of fly were reduced sufficiently for large scale settlement with cattle, which should complete the work of exterminating the fly.

The experiment is compared with the previous year's in the same block using gamma BHC, which reduced fly catches by some 30-40%. It is concluded that a combination of reduced swathe width, greater volume dosage and smaller lethal drop together with improved flying technique and the more reliable performance of the disseminating equipment was responsible for the improved result. It is thought that without delays, interruptions, incomplete applications and, possibly, reinfestation, even better results would be obtained.

This was the cheapest and one of the most successful operations carried out against savannah tsetse. Costs actually over the ground were £301 per square mile; incidental costs due to the locality of operations were £66 per square mile. There is little chance of reducing the cost of flying directly, but economics are possible by the use of other insecticides or, more probably, by more efficient dispensing equipment.

FILARIASIS RESEARCH IN FIJI 1957-1959

G. F. BURNETT. Colonial Pesticides Research Unit, Arusha, Tanganyika.

A report to the Secretary of State for the Colonies 157 pp. 2 maps, refs.

Author's Summary and Conclusions:

Work was directed principally to control of filarial transmission by reduction of vectors or of circulating microfilariae, but incidentally some information of epidemiological interest was obtained.

1. Methods of survey are described and a correction obtained for calculating what proportion of carriers is missed by examining 20 cm drops of capillary blood instead of 1 cc of venous blood.

2. A further series of age and sex distributions of microfilaraemia is given and it is shown that the preponderance of girls in young cases is not significant statistically, but the preponderance of men in cases of all ages is significant.

3. It is shown that in the 56 villages for which data is available there has been no measurable decline in filariasis as a result of the campaign initiated in 1944. Adequate sampling in blood surveys is difficult and in this case sampling was so inadequate that a decline in filariasis (unless complete or almost so) is probably impossible to detect.

4. Microfilariae have been found in the blood of mynahs and pigeons but these are not thought to be a complicating factor in blood surveys, in particular because medication in the Rewa Tikina caused a complete disappearance of filariae from mosquitoes, except for *D.immitis* of dogs.

5. Two new records of mosquitoes were made in the period. One *A.vigilax*, was an introduction, the other so far undescribed, was new species of subgenus *Findlaya*, genus *Aedes*.

6. Some miscellaneous information on biology is recorded. In particular the extensive utilisation of cultivated *Pandanus* for breeding by *A.fijiensis* inland on the Navua River.

7. It was found that, in four coastal villages, numbers of vectors remained remarkably high throughout some unusually dry spells. This is attributed to breeding in crab-holes by the bush vectors and to the ability of *A.fijiensis* to survive in the minimum of fluid. In four villages some way inland on the Rewa river delta, *C.fatigans* likewise maintained itself very well, in pit latrines. Purely pest mosquitoes fluctuated violently with the rainfall.

8. *A.vigilax:* which is known to be a vector of a periodic filariasis in New Caledonia, was found to be a very poor host of Fijian *Wuchereria*.

9. Dissection of many thousands of vectors demonstrated again the very low rate on infection in mosquitoes in Fiji. From these figures the mean daily mortality of the vectors was calculated as about 20% for the three *Aedes* and 29% for *C.fatigans*. Infections were found in mosquitoes in gardens, far from villages and infections were as abundant 3-400 yd from villages as they were at 0-200 yd, both on and away from tracks. There was no evidence that catches along tracks were inflated,

compared with those at village boundaries, because the mosquitoes had to wait for meal along the path i.e., catches made for an equal period in the two places were of equal value when finding mosquitoe densities.

10. From a study of the relative numbers of vectors in villages with differing rates of filaraemia it is concluded that *C. fatigans* is of minor importance as a vector and *A. polynesiensis* may be the most important, closely followed by *A. pseudoscutellaris*. *A. fijiensis* is important where it occurs but is restricted in distribution by its critical breeding requirements.

11. Dosage/mortality relations of the vectors and of *A. aegypti* were determined. Fijian *C. fatigans* and *A. aegypti* as larvae were unusually susceptible to DDT, BHC and dieldrin in water suspensions. *A. fijiensis* was notably insusceptible to DDT. A strain of *A. pseudoscutellaris* was readily obtained which was very highly resistant to DDT as a larva, showing no cross resistance to the other two insecticides and some adult tolerance to DDT.

12. Adult *C. fatigans* was as resistant to DDT as reported elsewhere but more susceptible to dieldrin. The dosage/mortality regression line is steep and part of the population would probably escape unhurt from a treated house. *A. fijiensis* is unusually susceptible to both DDT and dieldrin, as an adult.

13. Field control of *A. polynesiensis* and *A. pseudoscutellaris* was attempted only by attacking their breeding places. Cement insecticide pellets (dieldrin and BHC) were highly effective in preventing breeding in bamboo pots and dieldrin appeared effective in tree holes and crab holes. Crabs were best killed with 5% BHC or 0.5% aldrin in rice-bran bait. Reinvasion of a cleared area was slow but we were not able to demonstrate clearly a reduction in mosquitoes as a result of such measures. Spraying with 2½% dieldrin suspension and thatching with leaves both suppressed breeding in piles of coconut shells for several months.

14. Control of breeding by sanitation proved ineffective despite a great expenditure of energy. New artificial breeding sites were provided in abundance by the population and it is exceedingly difficult to destroy all natural breeding sites.

15. Felling wild *Pandanus* had a marked effect at one village but there is evidence that this is not always the case and extensive natural diversion of breeding to cultivated *Pandanus* was found in one area. Felling around a village may reduce transmission by lowering the proportion of mosquitoes with mature infections.

16. Larval control of *C. fatigans* by the use of old gear oil in latrines and of high spreading larvicides and dieldrin granules on surface water appeared to be successful in that breeding was not discovered, but many adults were found in the village. It is thought these came from outside the village, possible from the next one.

17. Spraying houses of a village with dieldrin emulsion had a marked effect on the numbers of *A. fijiensis* resting in them for at least 3 months after treatment at 26 mgm/sq. ft, at least 9 months after retreatment at 132 mgm/sq. ft, and at least 6 months after a third treatment at 52 mgm/sq. ft. The effect on entry was much more transient, under 2, under 3 and under 4 months respectively. It was not possible to show a significant reduction in mature infections because these had been few before treatment.

18. The effect on *C. fatigans* was less lasting when treated at 40 mgm/sq. ft the number of mosquitoes found resting in the houses was beginning to rise after four months and completely failing in seven. Entry was suppressed for less than three months.

19. Preliminary tests with diethylcarbamazine citrate on small numbers of subjects showed both short courses (6 doses) with high dosage rates and long courses (12 doses) with low ones were effective in reducing microfilariae to small numbers but on following up six months later it was found that the longer course appeared more effective for a given weight of drug. Two experiments started by Fiji Medical Department in 1956 were followed up and confirmed this. Consideration of cost and ease of administration decided us to try a short course at a higher dosage rate than any hitherto attempted in Fiji, for a mass-administration experiment.

20. Mass-administration of carbamazine citrate was carried out in Rewa Tikina. It was planned to give two courses of drug to everyone at approximately 6 mgm (citrate) per Kgm, per dose, six doses being taken at weekly intervals. 1,226 people completed the first course, 911 the second. The mean microfilarial infection rate was reduced from 12.2% to 2.7% five months after the second course and mean microfilarial density (20 cmm) from m.f.d. 4.04 to 0.36, reductions of 78% and 91.1% respectively. There was considerable movement in and out of the area which reduced the apparent effect of the drug. Reductions in m.f.r. and m.f.d. for people found positive were to 35% and 3.76% for one course (127 subjects) and to 8% and 0.24% for two (89 subjects). These results are discussed and it is concluded that in Fiji, with fairly low rates of infection and several vectors, the most promising line of attack is drug administration and tentative estimates for eradication are given which amount to about £700 per 1,000 people treated. It is thought that the full scheme would not be needed in many areas without active transmission. An even more tentative estimate for the suppression of clinical filariasis, which it is hoped would lead to eventual wiping out of the disease, amounts to £80 per 1000 people, to be repeated at intervals of several years.

A PHYSICAL ASSESSMENT OF AN AIRCRAFT AND GROUND APPLICATIONS OF SPRAY ON COCONUT PALMS IN ZANZIBAR

C. W. LEE and K. S. McKINLAY. Colonial Pesticides Research Unit, Arusha, Tanganyika, and B. H. HYDE-WYATT and J. A. PEARSON. Colonial Pesticides Unit, Zanzibar.
Arusha Miscellaneous Report No. 276.

Introduction

In Zanzibar, it has been observed that a considerable proportion of the female flowers produced by the coconut palms are shed at an early stage, resulting in the actual yield being appreciably less than the apparent potential. It has been shown that a certain amount of this premature nutfall is due to the feeding of the Coreid Bug *Pseudotheraptus wayi* Brown (Heteroptera). (Way 1953).

In an effort to control this pest, it has been the practice in the past for the C.P.R.U., to spray coconut palms in Zanzibar either by aircraft, or a ground machine. In order to investigate the relative merits of the two methods of application it was decided that physical assessments should be performed to compare an aircraft and ground application of spray with particular reference to the relative volume of spray deposited in the palm crowns by each method of application.

Description of Equipment

(a) The Aircraft

The Auster aircraft used in the trials, was fitted with two type A-100 Britten - Norman Direct Drive Micronair Spinning Cages supported below the wings of the aircraft. The type A-100 spinning cage equipment consists of a 4 bladed adjustable pitch propeller (set at $22\frac{1}{2}^0$ in this experiment) with a belt drive to a shaft on which are mounted five 2" x 6" diameter wire gauze cages. A 60 gal tank is fitted in the cabin of the aircraft and the spray liquid is fed to the atomisers by a gear pump. A pressure gauge in the cockpit records the pressure in the feed lines and in this trial a restrictor of 0.325 inches in diameter controlled the feed rate.

(b) The L.A.M.B. ground machine

In its original form the Long Ashton Mist Blower (L.A.M.B.) was due to Kearns (1955). Since its arrival in Zanzibar it has undergone several modifications.

The whole machine is mounted on a very strong built trailer with two, unsprung, pneumatic tyred wheels.

Location of trials

The site selected for the trials was the Mtoni Plot 23, which lies in the grounds of the old Marahubi Palace, some 2 miles north of Zanzibar town. The plot is adjacent to the beach, and the palms it contains are laid out in lines and rows, (the lines being roughly parallel to the beach) at an approximate 12 x 12 yards spacing.

Selection of sampling points

In order to remove as many varieties as possible and to have identical conditions of sampling in both trials, it was decided to select five definite sites in each palm crown. The sites were marked by attaching a clothes peg and were roughly defined as follows when viewed from the upwind side of the palm plot.

Position	Site
1	Top of the palm crown
2	R.H.S. of the palm crown
3	Base of the palm crown
4	Middle of the palm crown
5	L.H.S. of the palm crown

The targets consisted of table-tennis balls, mounted on wire hooks so that they could easily be attached and detached from the clothes pegs. Thus by replacing the table-tennis balls after the first trial, without moving the clothes pegs, spray deposit could be compared on identical targets in identical sites.

The spray solution used in both trials was a 50/50 Diesoline/Kerosene mixture containing 0.75% Waxoline Red and deposits on table-tennis balls were measured colorimetrically.

The mean application rates obtained from measurements during the course of the trials are shown in Table 1:

TABLE 1

	Emission Rate gal/min.	Swath Width yards	Speed m.p.h.	Applic. rate gal/acre 4 runs per swath
AIRCRAFT TRIAL	9.5	20	70	4.48
L.A.M.B. TRIAL	0.123	12	1.95	3.47

Considering the length of time the trials lasted, the relevant meteorological conditions were as stable as could be expected. The results are shown in table 2:

TABLE 2

		Air Temp. °F	Wind Speed ft/sec	Wind Dir. to °M	Rel. Hum. %	Amt. of cloud
AIRCRAFT TRIAL	Mean	74.9	6.7	030	91	8/8 st.
	Range	74.8-75.0	5.5-8.3	025-035		
L.A.M.B. TRIAL	Mean	76.6	6.7	047	89	4/8 st.
	Range	75.7-78.0	5.1-9.8	025-070		

The analysis of Variance of deposits is given in Table 3:

TABLE 3

Analysis of Variance Table

Variation due to:	Degrees of Freedom	Sum of Squares	Mean Square	F. Ratio
METHODS OF APPLICATION -A	1	1.0576	1.0576	20.3
PALMS -P	18	5.2495	0.2916	5.6
INTERACTION A X P	18	5.3501	0.2972	5.7
ERROR	152	7.9010	0.0520	
TOTAL	189	19.5582		

Only significant Main effects and Interactions are shown in the table, all others are included in the error term.

From table 3 it can be seen that there is a significant difference (P 0.1%) between the methods of application and it follows that the aircraft gave significantly greater deposits than the L.A.M.B.

In the aircraft trial it was found that there was a positive correlation of the total volume of spray deposited on targets in palms with increase of palm height. The authors are not certain whether this correlation arises from a shading effect in the palms or a loss of spray due to drift over the lower palms.

In the L.A.M.B. trial it was found that there was a rapid fall off of spray deposit in palms with increase of palm height. It would therefore be advisable to collect more information of the variation of palm heights in plots to be sprayed with a view to relating this physical assessment with future biological control.

PYRETHRUM NEWS

The Pyrethrum Board of Kenya. Annual Report and Accounts for the Period 1 July 1959 to 30 June 1960.

Field Trials against Antestia on Coffee

Following the field trials which were conducted in collaboration with the Kenya Coffee Research Station last year, a further trial was made on 1,000 acres of African coffee plantations at Kisii using 0.006% pyrethrins on the foliage and a 5% DDT dust on the base of the tree. This gave a very adequate degree of control as reflected by a decline of insect populations and a marked improvement in quality of the coffee.

The concentrate, in 5 cc capsules, for testing Antestia populations in coffee trees, and in bulk for spraying plantations, is now available to coffee growers in East Africa.

Field Trials against Leaf Miner on Coffee

Field trials now in progress indicate that 0.001% pyrethrins effects high mortality to eggs of leaf miner and controls the adult moth.

Field Trials against Aphids on Peas

Laboratory work indicated piperonyl butoxide to be an effective synergist of pyrethrum against aphids, the optimum ratio of piperonyl butoxide/pyrethrins being 4:1.

Field trials in Kenya and in England have shown that two sprayings, at 10 days' interval, with 0.006% pyrethrins/0.024% piperonyl butoxide at 80 gallons/acre, give excellent control of aphids without causing harm to ladybirds. Similar results have been obtained on French beans.

It has also been shown that a 0.2% pyrethrins/0.8% piperonyl butoxide dust (made from ground pyrethrum marc) at 25 lb/acre gives excellent control and a high degree of persistence.

Improved formulations with superior wetting power are being prepared for testing.

Field Trials on other Crops

Field trials are proceeding against white fly on tomatoes, aphids on cucumbers, yellow tipped borer on coffee, and the maize stalk borer on maize.

Examination of Barthrin

The synthetic analogue of pyrethrin/piperonyl butoxide has been examined against a range of insects and shown to be much less active than natural pyrethrum.

Synergists

Four synergists, piperonyl butoxide, "Sulfoxide", "Bucarpolate" and "S.421"*, have been carefully screened for activity in synergising pyrethrum against a range of insects. Results showed that piperonyl butoxide and "Sulfoxide" are equally good and each is superior to "Bucarpolate" and "S.421". "BPS 50" has been shown to have little synergising power.

* *Note:* S.421 = Octachlorodipropyl ether (with 1% stabiliser) (Badische Aniline-und-Soda Fabriken A.G.)

A COMPARISON OF TWO TRACTOR MOUNTED AIRBLAST SPRAYERS FOR APPLYING LOW VOLUME SPRAYS TO MULTIPLE STEM COFFEE

K. S. McKINLAY, E. T. MESMER and C. W. LEE. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 274.

Two tractor mounted sprayers capable of applying air-blast assisted low-volume sprays to coffee were available for test at the Coffee Research Station, Jacaranda, during May, 1960. These were the Micron Twin, manufactured by Micron Sprayers Ltd., 58, Battersea High Street, London, S.W.11, and the Chiron, manufactured by the Chiron-Werke, Tuttlingen/Wurtt, Germany.

The comparison of deposits on multiple stem coffee sprayed by both the Micron and the Chiron suggested that under the conditions of this test the Chiron gave a rather better cover with higher deposits on most parts of the trees. There were fewer sites with very low deposits and less variation of deposit.

However, it should be borne in mind that the results obtained with machines of this type depend very much on the exact settings of the spray outlets and although every effort was made to use those that appeared to be optimum settings in each case it is quite possible that alternative settings would have altered the performance of the machines considerably.

It is felt that both machines have an inherent limitation in that number of outlets is limited and they are grouped close together near ground level. It is possible that if the outlets were separated and arranged up a vertical boom not only would coverage with height be improved but also the outlet settings would be less critical.

PERFORMANCE OF BRITTEN-NORMAN SPINNING CAGE SPRAY GEAR FITTED TO A D.H. BEAVER AIRCRAFT

C. E. McKONE and C. W. LEE, Colonial Pesticides Research Unit, Arusha, Tanganyika and H. J. SAYER, Desert Locust Survey, Nairobi, Kenya. Arusha Miscellaneous Report No. 258. February, 1960.

The Desert Locust Survey operate D. H. Beaver aircraft and these are being fitted with Britten-Norman spinning cage atomisers. A series of trials have been carried out to determine the performance and spray characteristics of the spray gear.

Emission Tests

A series of emission tests was carried out with water using numbers 13 and 8 settings on the quadrant control (corresponding to fully-open and about half-open respectively) and a range of restrictors in the feed lines. The variations in emission rate obtained in trials 6, 9 and 10 using No. 6 restrictors and the same quadrant setting (No. 8) indicated that the quadrant control was unreliable and this has been confirmed elsewhere by pilots of Desert Locust Survey. It was decided therefore to ignore the quadrant settings as a means of control of flow rate and to always use it fully open at position thirteen and that only restrictors would be used for flow control.

During these trials, the revolutions per minute of the port unit was observed by stroboscope to be greater than those of the starboard and examination of the pitch settings showed that the former was 15° and the latter 20°. Bringing both to 15° did not alter this discrepancy and during all the trials, whenever stroboscope observations were made, this discrepancy was always found.

Determination of Droplet Distribution and Emission Rates

The first three trials aimed at covering the range of emission rates and the fourth repeated the lowest rate but in this case the cages were lined with fibre-glass in order to see whether the liquid was picking up the speed of the cages before being ejected, it being assumed that the fibre-glass mat (which consisted of 6 strips of fibre-glass staple tissue weighing 11.6 gms per cage) guaranteed that all the liquid leaving the cages was travelling at the peripheral speed of the cage.

During these trials it was observed from the ground that a considerable drop in pitch of the sound being made by the spinners occurred when spraying started. Consequently a further series of trials was carried out with the stroboscope in order to determine what was the amount of this drop. For comparison, two trials were also carried out with the C.P.R.U. Auster fitted with type A-100 (belt driven) units. The pitch angle of the blade can be connected with the forward speed of the aircraft assuming no slip by the formula

$$F = R\pi D \tan P$$

Where F is the aircraft flying speed
D is the fan diameter
P is the pitch angle
R is the revolutions per minute

It is possible to express the revolutions per minute recorded as percentage of theory. Since the blade angles are constant and do not vary with radial distance as in normal airscrew design, a mean diameter was taken which in this case with 4 inch blades and 13 inch outside diameter is 9 inches. Coarsening the pitch did not improve the revolutions and it is obvious from the results obtained that there is a considerable load braking effect on the spinner. The A 100 type equipment on the Auster set to a 22° pitch appears to slip less under load than the A 1000 and this is to be expected in view of the coarser pitch.

Discussion

With the extremely limited numbers of trials possible, there are not enough results available to be able to correlate completely the results, but with a view to future confirmation or otherwise, a simple graphical relationship was constructed between the M.V.D. and the actual r.p.m. and emission rates can be arranged to test this graph and it may be possible to correlate the tests of different types of aircraft and spray gear by the peripheral speed of the spinning cages, which is the fundamental drop forming factor.

There was no significant effect from the fibre-glass but this may be due to the fact that it was tested at the lowest emission rate. Higher emission rates might be expected to be more affected by the addition of fibreglass.

From the confirmed characteristics of a spinning top, it might have been expected that a similar connection between drop diameter and cage speed would have been found. For spinning tops

$dw = KD^{\frac{1}{2}}$ for the same liquid
where d is the drop diameter
w is angular velocity
$D =$ disc diameter. $K =$ constant
or since D is constant
$dw = K$

From the results of the trials, dw decreases with emission rate, and this may be an indication that the higher the loading the greater the tendency for the liquid not to be accelerated up to cage speed and a further series of trials using fibreglass are desirable to clarify this point.

DEPOSITION OF DROPLETS

PART 7. - DEPOSITION ON VERTICAL CYLINDERS EXPOSED TO A COARSE AEROSOL OF 28 MICRONS V.M.D.

D. R. JOHNSTONE. Colonial Pesticides Research Unit, Porton. Report No. 180. Oct. 1960.

Summary

The collection efficiency of a coarse aerosol by vertical cylinders has been measured. It is found that the inertia process causes deposition similar to that predicted by computation for ideal flow, provided that the ratio of mean droplet diameter to cylinder diameter is less than about 0.025.

If this ratio, termed the interception parameter, becomes greater than 0.025, the difference between the total measured collection efficiency and the computed inertial collection efficiency exceeds the theoretical interception efficiency by approximately 50%.

The possibilities and limitations associated with the use of rods and wires for sampling coarse aerosols are discussed.

A PRECISION WALL SPRAYER

G. F. POULTON. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 272.

It is often necessary to carry out bio-assays of insecticides on vertical surfaces such as the walls of huts and for this purpose a deposit more even than that given by a manually operated sprayer is required. In an attempt to solve this problem a power-operated sprayer has been designed that sprays a vertical surface at a known speed from a fixed distance and gives accurately known, even, and reproducible deposits. Surfaces up to 4 ft high and of indefinite width may be treated.

Description

The machine consists of "Dexion" perforated angle iron framework 5 ft high and 4 ft wide supported vertically by an 18" deep framework extending rearwards from the base, upon this framework are fitted chain sprockets over which runs an endless bicycle chain. To this chain is fitted a combined on/off tap and spraying nozzle holder. When the chain is set in motion the spraying nozzle follows the path as determined by the sprockets and chain and an automatic device permits the nozzle to spray only when moving vertically.

An Allman No. 1 ceramic, type "B" fan nozzle with an output of 650 ml. per minute at 50 lb per square inch was ultimately selected. Using a swathe width or chain spacing of 30" and placing the nozzle 32" from the wall with a speed of 1.66 ft per min, the deposit obtained was then sensibly uniform over a vertical band 36" wide. Colormetric assessments across the test strip showed that none of the inch square sample areas received less than 0.0098 ml of spray, no more than 0.0168 ml. In practice only this selected portion of the spray pattern would be used and the remainder stopped by means of screens from reaching the surface to be sprayed.

A LABORATORY COMPARISON OF DIELDRIN AND ALDRIN

W. R. BRANSBY-WILLIAMS. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Arusha Miscellaneous Report No. 275.

It was suggested that aldrin might be better than dieldrin as a spray against tsetse flies in the field, and the laboratory comparison of the two insecticides which is described below was made in order to see whether results would encourage further laboratory and field tests.

Methods

Flies were exposed to the insecticides by three methods: by a modified version of the Busvine/Nash method for mosquitoes, by topical application and by spray in a Potter Tower.

Where there were sufficient results, the percentage mortalities and concentrations of insecticide were plotted on log/probability paper and a profit regression line fitted by eye so that the approximate LC 50 and LC 99 values could be read. The comparison of the concentration of insecticide which would just kill 100% or the dosage which would be expected to kill 99% would appear to be the most important, but with the small numbers of insects tested at each concentration, much more reliance can be put on the LC 50 value. However both LC 50 and LC 99 values are given where possible.

Results

In order to have sufficient flies at any concentration the male and female mortalities have been added together for these results.

The control mortalities were highest with the Potter Tower Spray where for the dieldrin treated fed flies it was as high as 12%, and they were lowest for the modified Busvine/Nash test with 3 and 4%.

The LC 50 and LC 99 values for fed and unfed flies for the topical application and Potter Tower spraying, and for the fed flies only for the Busvine/Nash test, are given in the accompanying table. There were insufficient results for unfed flies with aldrin for the Busvine/Nash test for a probit regression line to be fitted, so the percentage mortalities for concentrations of both insecticides of 0.2, 0.4, 0.8 and 1.6% are given.

The LC 50 values of the blood fed *G.morsitans*, 1 - 5 days old tested 1 - 3 hours after feeding, were all lower with dieldrin than for the unfed newly hatched. This confirmed the earlier work mentioned above, this difference did not show up with aldrin.

Wherever LC 50 and LC 99 values were obtained, it will be seen that dieldrin is never less than twice as effective as aldrin. The difference between the LC 50 values is least noticeable with the Busvine/Nash test where it is of the order of 2-3 times, more so with the Potter Tower where it is 3-8 times and most noticeable for the topical application where it is 5-14 times.

The comparative East African prices of dieldrin and aldrin, supplied by Shell Chemical Co., are 14 : 9.

Conclusion

Even with the slightly higher cost of the dieldrin, it is, under the conditions of these tests, a more efficient insecticide than aldrin against *G.morsitans*. Although the number of flies tested was small, only one species of tsetse was used and the solutions were made only from the technical form of the insecticides, the results of these tests indicate that aldrin should not be used as a substitute for dieldrin in spraying against tsetse and it seems unlikely that more extensive trials would produce any different result.

Table. Comparative LC 50 and LC 99 values for *G.morsitans* treated with dieldrin and aldrin

Method	State of Flies	Concentration of Solution %			
		Dieldrin		Aldrin	
		LC 50	LC 99	LC 50	LC 99
Topical	Blood fed	0.0026	0.033	0.037	1.0
Application	Unfed	0.0073	0.027	0.033	1.8
Potter	Blood fed	0.0011	0.05	0.009	0.12
Tower	Unfed	0.0032	0.049	0.011	0.14
Busvine/Nash	Blood fed	0.23	1.8	0.48	6.0

Concentration of insecticide %			0.2	0.4	0.8	1.6
Busvine/Nash.	Corrected	DL	34	62	85	100
Percentage mortality.	Unfed	AL	0	17	64	100

THE PERSISTENCE OF ALDRIN EMULSION SPRAYED ON TO SOIL

E. T. MESMER. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Miscellaneous Report No. 253.

Aldrin, in the form of a diluted emulsion concentrate, is sprayed on to the soil during the planting of sugar cane to control the red cane beetle *(Cochliotis melolonthoides)*. Soil surface temperatures can exceed 50^0 C and it was thought that there might be a considerable loss of aldrin from the soil during the period between spraying and the final covering of the insecticide.

Results

The results of the experiments, given as mg aldrin per square foot, are the mean figures from four samples taken at each time.

Experiment I. Aldrin spray containing 0.58% aldrin

Time after spraying in hours.	Initial Deposit	1	2	3
mg aldrin per sq./ft	21.5	21.8	17.3	18.2
Soil surface temperature ^{0}C.	43	46	52	52
Mean temperature		48^{0}C		

Experiment II. Aldrin spray containing 0.62% aldrin

Time after spraying in hours.	Initial Deposit	1	2	3	5	7
mg aldrin per sq./ft	34.8	43.0	34.4	37.1	32.6	33.0
Soil surface temperature ^{0}C	54	43	53	32	31	28
Mean temperature		40^{0}				

Conclusion

There is no significant loss of aldrin, during a period of three hours, when sprayed on to the soil at a rate of approximately 1 lb/acre, with an average soil surface temperature of 48^{0}C. Neither is there any significant loss of aldrin during a seven hour period when applied at 1.5 lb/acre at an average soil surface temperature of 50^{0}C for the first two hours and a subsequent average temperature of 30^{0}C. The insecticide is usually covered with soil within 2 hours of being applied and consequently any loss of aldrin from the soil due to volatilisation at high soil temperatures is negligible.

QUELEA CONTROL

A symposium of Quelea bird control was held at Bamako, Sudanese Republic, on the 17-21 May, 1960 under the joint auspicies of the CCTA and FAO. The report has just been issued. Reference L(60) 79 P.M.B. 2359. Lagos, Nigeria.

The recommendations were that increasing sums should be spent on research and control as no advance will be made until funds were adequate.

It was essential to exchange information and this would best be done through the new body that had been set up in West Africa known as "l'Organisation Commune de Lutte Antiavaire" (OCLAV) responsible for bird control in Mali, Mauritania and Niger and it was considered desirable to extend it to the whole region.

It was further recommended that control should be intensified and that the specialized international agencies should give every possible assistance. With regard to research it was urged that recommendation No. III of the Livingstone meeting be implemented: this called for a campaign of ringing at the rate of 100,000 rings per year, over 3 years.

Research on toxic products having fewer after effects and on methods of application should be continued. Fundamental research on physiology, behaviour and diseases of Quelea was needed. The auditive behaviour of the pest should be studied as also the biotypes associated with it.

The expenditure envisaged over three years was:

Capital	£17,550	£11,700
Operating expenses	39,600	26,400
Rings and nets	3,300	3,300
	£60,450	£41,400
Total		£101,850

TIMBER PROTECTION

Forest Products Research 1959. Department of Scientific and Industrial Research. H.M.S.O. London 1960.

Insecticides

Contact Insecticides: Further tests with death-watch beetles have shown that an exposure period of 48 hours to dieldrin deposits of 0.04 mg/sq.cm are necessary to prevent egg-laying when the beetles are transferred to untreated, decayed, oak sapwood.

Tests were carried out in 1956 and 1957 with English oak sapwood dipped for 10 seconds in a number of solutions and exposed subsequently to egg-laying by the death-watch beetle (see the Annual Report for 1956, p. 42, and 1957, p. 37). Treated blocks from these tests which had previously resisted infestation were re-exposed in 1959 and it has been found that all materials remained effective in either preventing egg-laying or hatching or successful larval penetration into the wood.

Scots pine sapwood blocks dipped for 10 seconds in solutions of dieldrin and BHC at concentrations of 0.5, 0.3, 0.1 and 0.05 per cent were exposed to common furniture beetles for egg-laying. Although a very small number of eggs were laid on one block dipped in 0.05% dieldrin solution and on one dipped in 0.1% lindane, none hatched. Viable eggs were present on blocks dipped in white spirit, but fewer than on the untreated control blocks.

Gamma Radiation

Results of particular interest are those concerning the eggs of the common furniture beetle. Previous data showed that eggs in which embryonic development was advanced were extremely resistant to radiation, and doses in excess of 96,000 roentgens (r) were needed to prevent hatching. A total of 794 eggs of known age (13 to 21 days old at the time of treatment) have been irradiated at a series of dosages between 6,000 r and 20,000 r, but only four eggs, 19 days old, irradiated at 8,000 r hatched, whereas 39 of the 50 untreated control eggs of similar ages were viable. The limits of the incubation period of the controls were 22 to 33 days. The greatly increased susceptibility of these mature eggs to gamma radiation compared with previous results is thought to be due to conditions of storage. Previous experiments have been conducted under out-of-door conditions but, in this instance, they were carried out indoors in a non-insulated wood hut in which high temperatures were recorded during the unusually hot weather prevailing. Such an adjunct effect of high temperature in increasing the potency of gamma radiation has not been previously noted in the case of wood-boring insects, although a similar effect was detected in the chalcid *Dahlbominus fuscipennis* by Baldwin and Narraway, who found that the killing power of X-rays on the females was greatly increased if higher than normal temperatures were applied after treatment.

Examination of eggs laid by death-watch beetles irradiated in the autumn of 1957 at an early stage in their hibernation, at dosages from 6,000 r to 15,000 r, has been completed and the results of egg-laying and hatching examined statistically. Results quoted in the 1958 Annual Report (p.40) showed that eggs laid by beetles, when both sexes have been irradiated at and above 10,000 r and then mated together, did not hatch. Completed data now show that when treated beetles were mated with untreated specimens of the opposite sex, a few fertile eggs (approximately 1 per cent) were laid at the highest dosage.

Infra Red Heating

Further experiments carried out with naturally infested birch plywood showed that when the temperatures on the unheated face of the wood exceeded 55°C a larval mortality of 100% was reached. This is comparable with the data previously obtained for *Lyctus* in obeche plywood (see Annual Report 1956, p. 44) but lower than that found necessary in the case of *Lyctus*-infested oak where 60°C caused less than 100% mortality.

Wood Preservation

Preservatives - General

No new work has been undertaken but the long-term tests of the residual toxicity of surface treatments (see the Annual Report for 1958, p. 31) have been continued. Treatments with creosote, 4 per cent sodium pentachlorophenate and 5% sodium ortho phenylphenate remain effective after 30 months.

Information required for completion of the revision of the British Standard test of the toxicity of wood preservatives has been supplied. Wood block toxicity tests of the resistance to copper napthenate and pentachlorophenol of the strain of *Poria monticola* employed in American standard test of wood preservatives are in progress.

Ageing of Creosote

It has lately been shown that extraction with a single solvent such as toluene, which is the standard procedure for freshly treated wood, does not give complete recovery of creosote residues in timber that has been in service for a long time. This is especially so where the timber has been exposed to the weather, and it is necessary to make separate extractions with two different types of solvent to obtain a satisfactory recovery. Some work has been carried out at the Laboratory on the estimation of aged creosote residues and with some 48 years old material the above finding has been confirmed. On the other hand practically the whole of the creosote residue was recovered by a single solvent from the 30 year old posts examined in the present investigation. This suggests that the changes in creosote which occur during service, causing it to become partially insoluble in certain solvents, may occur to considerably different extents, possibly because of variations in the composition of the original creosote or different periods of service.

Immersion Treatment

There is not very much difference in the amounts of the different preservatives absorbed by Scots pine sapwood during immersion but there are considerable differences between the depths to which they penetrate. Certain of the organic solvent type are the most penetrating and the water solution type are the least; one has about six times the penetrating power of the other. Conversely the concentration of the organic solvent type in the penetrated part of the wood is only about one sixth as great as that of the water solution type. These differences in penetration and concentration between the various types of preservatives are probably a main cause of the anomalies which occur from time to time in the testing of preservatives applied by superficial methods.

Investigation into the reasons for these differences in penetration has shown that the depth to which a preservative penetrates during immersion is primarily a function of its viscosity and its surface tension. With some preservatives, however, other properties play a predominant part and work on this part of the investigation is still going on. A report on the work completed so far as been prepared.

INSECTICIDES FOR USE IN SOUTH PACIFIC AREA

From an Article by B. A. O'CONNOR published in the South Pacific Bulletin, October 1960, *10*, (4).

The development of potent synthetic insecticides during and since the second World War has revolutionized this very important method of insect control, and - though the emergence of resistant strains of insects has introduced complications - the intelligent use of insecticides is indispensable in controlling the majority of insect pests.

Twenty years ago insecticides were classified in two groups, namely, contact insecticides and internal poisons. Contact insecticides were used to control sucking insects, and stomach poisons to control chewing insects. The contact insecticides had little residual effect, so that it was necessary when spraying to hit each individual insect with the spray fluid, in order to obtain a high mortality.

Most modern insecticides in common use kill by both contact and ingestion, and have some degree of persistence. Hence many sucking insects, as well as chewing ones, can be killed by a spray which is not specifically directed against the bodies of individual insects. Now only some sedentary insects need to be directly hit by the spray, others being susceptible to systemic insecticides, which they ingest with the sap of the plant.

Today there is available such a bewildering array of insecticides that it is sometimes difficult to decide which is the best to use. In the South Pacific area, where there is a dearth of people skilled in the handling of insecticides, and where the wearing of protective clothing would be hardly tolerable because of the warm and humid climate, insecticides which are highly toxic to man should be avoided.

Among the more common organic phosphorus compounds, parathion is dangerous, malathion is very safe, and diazinon quite reasonably safe.

Of the systemic insecticides (those which are absorbed into the tissue of the plant) many are highly toxic to man, while others, such as "Rogor" and "Metasystox", can be safely used with reasonable care. Among the chlorinated hydro-carbons. BHC and lindane, DDT, chlordane, aldrin and dieldrin are all safe if used with reasonable care, but endrin and isodrin are more dangerous. Some of the carbamates are highly toxic, but "Sevin", for instance, is quite safe.

It is, of course, necessary to handle insecticides with care. Contact with and inhalation of sprays and dust should be avoided as far as is possible, and one should wash thoroughly after using them.

A little forethought will help in minimising contamination. For instance, if there is any wind, it is wise to begin treating a field from the leeward side, so that drifting spray fluid or dust will be blown back on to the rows already treated. In this way the operator keeps moving into the uncontaminated area.

The choice of a suitable insecticide for control of a specific insect pest can be made on advice from staff members of Agricultural Departments and from representatives of firms which deal in insecticides.

Most modern insecticides are effective against chewing insects, and also against many sucking insects. Some are specifically good against certain pests, as for example dieldrin and chlordane for ants (which often foster mealybugs, scale insects and aphids) and for soil-inhabiting insects. Organic phosphorus insecticides control a wide range of aphids, mealybugs, scale-insects, mites and leaf-mining insects.

Systemic insecticides are especially valuable against aphids, which are difficult to control by using contact sprays. Systemics have the advantage of killing the pest without affecting predators such as ladybird beetles, and they also have considerable residual effect, which protects leaves which unfold after the time of application.

There are various methods of applying insecticides. In the South Pacific area small applicators such as knapsack sprayers, rotary dusters and small mist-blowers are normally used. Tall crops such as coconuts call for treatment by aircraft or large dusting machines.

Application of insecticides in the form of a spray has the advantages of lower cost of materials and greater resistance to being washed off by rain. Dusting is quicker and less laborious than spraying. Mist-blowing combines the advantages of both sprays and dusts, but the capital outlay is greater.

No matter what equipment is used, thoroughness of application is necessary. Investigation of complaints by farmers that an insecticide is ineffective often show that application has been poor and a totally inadequate quantity of insecticide has been applied.

Baits and traps should be mentioned in passing though they do not at present have wide application in the South Pacific area. Baits may be used for pests such as armyworms, and overseas there has been considerable use of chemically-baited traps, light-traps and sticky bands. Pests such as the rhinoceros beetle and palm weevils would appear to be likely subjects for trapping, and the South Pacific Commission is carrying out research into chemical attractants for the rhinoceros beetle. It is possible also that certain types of light-traps could be used against pests of nocturnal habit, for which really satisfactory measures of control are not known. The so-called "black light" is very attractive to many species of insects.

RECENT DEVELOPMENTS IN APPLIED ENTOMOLOGY

Notes of progress in entomology prepared by the Director of the Commonwealth Institute of Entomology, reproduced by kind permission of the Executive Council of the Commonwealth Agricultural Bureaux, from its 31st Annual Report, 1959-60.

To the casual observer on the bank, the progress of a boat being rowed upstream may seem disproportionately slow in relation to the energy expended by its crew. Progress in agricultural entomology is generally similar, and a proper evaluation must take into account the force of the opposing current. This, in the main, is represented by the natural resilience of biological material, and by the undesirable side-effects of men's own agricultural activities. The biota is so delicately balanced, and ecological niches so well filled, that scarcely any change can be made without benefiting some arthropod or other. The trend towards intensive cultivation, slow but inevitable, involves an increasing degree of environmental control, and action to this end results not infrequently in creating, or prolonging, circumstances which favour the multiplication of insects. Where irrigation has been introduced, for example, more than one hitherto negligible insect is now appearing as a crop pest (as, for example, *Baris granulipennis* Tour. on water-melons in Israel,) or recognised pests are able to maintain their numbers at an injurious level. The situation may be similar where crops are grown successively instead of intermittently: in Central and East Africa the sorghum midge, *Contarinia sorghicola* (Coq.) which is uncommon in peasant holdings, is a pest at agricultural research stations where sorghum is constantly present. Even the application of insecticides, in appropriate climatic conditions, may pave the way to a renewed outbreak of the very pests against which they are used, by clearing the field of both the pest and its complex of enemies, and so permitting early recolonisation of the area by survivors or immigrants.

The use of insecticides furnishes a swift answer to many problems of economic entomology, and this approach is deservedly popular. But the cost of effective treatment increases proportionately as the insect pest acquires resistance, and can rapidly become uneconomic. The search for insecticides which are effective and cheap needs to be maintained constantly and over the past few years has been prosecuted with increasing vigour: the result is reflected in the number of insecticidal compounds now in regular commercial use, which is almost four times that only seven years ago. The task of testing these against a wide variety of pests is today a major activity, and the reports of such tests form about a quarter of the total literature on applied entomology.

At the opposite end of the chain of events which makes such tests possible, an appreciable amount of fundamental research is devoted to ascertaining the metabolic changes in the subject which supervene in the presence of insecticide, to discover how the insecticide operates within the body and by what means, if any, it is detoxified; such studies embrace not only insects, but vertebrates and even plants, and in the first extend to cover transmissibility of insecticide resistance from parent to offspring. The requirements which have to be considered in developing new compounds are many, but the two basic factors are humanitarian and financial. In one approach the attempt is made to widen the gap between levels toxic to insects and those toxic to mammals in another, to increase toxicity to insects and so reduce cost. The end to be achieved is usually death of the insect, but, where chronic infestation has to be dealt with, it is recognised that even a lowering of fecundity might lead to an adequate reduction of the population.

With the safety margin so narrow in some of the more recent insecticides, their adoption for widespread use presupposes a working knowledge of the conditions in which they may produce adverse effects. Much of the investigational work in this field, discussion of which occupies about two and a half per cent, of the total literature, has been devoted to measuring the amounts of insecticide in food obtained from plants or stock which had received treatment. On the whole, the findings have been generally reassuring, as far as hazard to human health is concerned, but as regards quality and flavour of produce it would appear, in some crops, difficult to ensure that treatment will affect neither, irrespective of the prevailing environmental conditions. From similar precautionary motives, studies have also been made of insecticides in the soil, of their movement, persistence, and effect on seed germination and growth of seedlings, and of their effect on the soil fauna. It seems clear that each system (soil type, weather, and the biota concerned) has to be evaluated by itself; there is little basis for generalisation, apart from the fact that undesirable effects may, at times, result even from normal use of insecticides in apparently normal conditions. The last of the common items in this aspect of study is the incidental injurious effect of insecticides on insect predators and parasitoids and on flower-pollinators. The findings, which are derived from a comparatively small number of investigations, suffice to indicate the need for careful choice of insecticide if such injury is to be kept to a minimum.

The use of toxic gases has been given relatively little attention, and such investigations as have been reported have been chiefly concerned with technical details regarding well-known fumigants against storage pests. On this front, at least, the position seems to be satisfactory and reasonably stable.

Systematic investigation of the problem of repelling insects has virtually been neglected in the recent past. In a fundamental approach, the relevant properties of olfactory stimulants have been studied in relation to response in *Glossina* and *Phormia* in order to estimate the most promising combination of physical properties for securing a response. In one of the few other studies it was reported that the insects tested were repelled (or even poisoned) by the dried and powdered remains of specimens of their own species, but not by those of other species. The repellant effect of certain insecticides against specific pests has also been remarked fairly frequently but there has been little attempt to exploit this property. Little has been reported, too, in the complementary line of investigation, the study of attractants: the principal feature in this field has been work centred on compounding mixtures of high attractiveness to adult fruit-flies.

The physical and mechanical aspects of applied entomology have formed the subject of comparatively few reports. Methods of application have included no really novel approaches, unless the introduction of insecticidal resins is regarded as such, but it is evident that an appreciable amount of effort has been expended on attempts to adapt low-volume spraying technique to a wide range of problems. In forestry work, methods are being sought to permit more extended use of aircraft as a means of surveying insect infestation; it would seem that the more obvious situations for economic use of conventional aircraft for application of insecticide have already been exploited.

Studies on the effect of radiation on insect pests and on their parasitoids have understandably not been common, as the field is comparatively new, and have largely been in the nature of exploratory skirmishes. The main lines have been the investigation of methods for producing "tagged" insects in the developmental stage needed for subsequent observation, and examination of the effect of irradiation on insect populations. The effect of heat induced by infra-red rays and electromagnetic microwaves was studied in relation to *Stephanoderes hampei* (Ferr.) in coffee beans and *Tribolium confusum* Dew. and *Sitophilus granarius* (L.) in flour and whole wheat of X-rays in relation to *Bracon hebetor* Say, and of X-rays to *Trogoderma sternale* Jayne mostly to observe physiological reactions after irradiation at various combinations of intensity and duration.

With so much field activity devoted to the problems of chemical control of pests, other aspects of applied entomology appear to be receiving less attention than their importance merits, and although the reports of such work at first sight seem to make a respectable total, they are in fact dispersed thinly over a wide range of topics.

There has been a moderate and steady amount of activity in the biological control of insects by the introduction of natural enemies, but the most noteworthy feature in this field has been the quickening of interest in the parallel approach using fungal, microbial or virus pathogens of insects. Investigations of the specific conditions most suitable for the rapid spread of such pathogens has so far has been very limited. Where fungi are concerned it is evident that the degree of effectiveness is to a large extent governed by the vagaries of weather, but it is, as yet, a moot point whether their victims have to be 'softened up' by environmental adversity as a pre-requisite to successful infection. Work on the use of bacteria in insect control has been reviewed by Grison. In the field of virus transmission an informative investigation by Clarke has established that the polyhedrosis virus of *Malacosoma fragile* (Stretch) can persist through the winter on inedible parts of the food plant and can infect larvae of the succeeding generation. As a corollary to the increasing attention to this aspect of insect control, a discussion has appeared on the advisability of standardising under regulation the microbial products which may be developed and marketed for this purpose.

There have been few new projects for the suppression of weeds by the introduction of specific insects in the period under review. The control of *Cordia* in Mauritius by a defoliator, *Schematiza cordiae* Barb., and a seed-destroying species of *Eurytoma* has been completed and, in Australia, a shipment of *Hylemyia seneciella* (Meade) has been received from New Zealand for use against ragwort.

Such, broadly, is the latest entomological chapter in the saga of scientific ingenuity aimed at destruction of the biologically unwanted. What remains to be considered may be described as fact-finding with a lesser expectation of results of immediate practical application.

The list of insect pests has continued to lengthen; in some instances the elevation of status results from incrimination as a vector of disease. The vector relationship itself has provided interesting subjects for study; feeding period in relation to subsequent infectivity, transmission of infectivity through the egg stage to the succeeding generation, differences between strains, or clones, of vector in ability to transmit and, in the Aster Yellows and Peach Yellow Leaf Roll viruses, pathogenic changes in the vector after infection with the virus.

The insect itself has been the object of a moderate amount of study. Several of the investigations have been concerned with the effect of heat, cold, or humidity on various phases of development. The effect of high temperature of the egg stage was studied in fruit flies in Hawaii, and in the Georgian Republic, and in cutworms in western Canada; on the colour and weight of newly-hatched grasshoppers in India; and on the aestivating habits of the alfalfa weevil (*Hypera variabilis* Hbst.) and of *Hylemyia lupini* (Coq). in the U.S.A. At the opposite extreme the effect of low temperature was investigated from the standpoint of estimating the susceptibility to cold of larvae of the European corn borer, *Pyrausta nubilalis*, and of adults and eggs of the leafhopper *Colladonus* and of the eggs of the European red mite, *Panonychus ulmi*. Studies of humidity relations included those of eggs of the garden chafer, *Phyllopertha horticola*, which absorb nearly twice their own weight of water during incubation and of adult spider mites. In five species of the latter, as represented by Tetranychus, it was found that the number of eggs laid by a female, and the length of oviposition period, were greater at low than at high relative humidity.

Studies of oviposition behaviour also involved climatic phenomena. In *Locusta migratoria* L., it was found that moist sand was preferred for oviposition, as was also a temperature approaching 100 degrees F: in *Ceratitis capitata* Wied., in a comparison of behaviour under different light intensities, it was found that females seek shaded sites for their eggs and in a comparison of the attractiveness of haricot beans to *Acanthoscelides obtectus*, it was established that a variety which was less attacked while on the plant in the field was also less attacked when stored, the difference being attributable to oviposition preference. Another phase in insect development associated with climate, if only indirectly, is diapause. In *Plodia interpunctella* Hb. and *Mamestra brassicae* L., cooling in the early developmental stages was found to be followed by diapause in the fully fed larva and in *Cephus cinctus* Nort., in addition to the normal autumnal diapause, a second diapause may be induced by heating the overwintered larvae before they begin metamorphosis. In *Tetranychus telarius* L., at temperatures below 25 degrees C, a shortened photoperiod has been found to be the factor mainly responsible for the production of overwintering females in the Leningrad area, and the critical photo-period has been calculated to decrease by one hour for each reduction of 3 degrees in latitude.

The problems involved in the relationship between insects and their sources of food have attracted surprisingly little attention in view of their variety and importance, but useful contributions to knowledge in this field have nevertheless been forthcoming. An increase of adult emergence was obtained by maintaining oak or hickory infested with *Lyctus planicollis* Lec. at a moisture content of 15-18%. The high mortality observed among larvae of the European corn borer was found not to be caused by any nutritional deficiencies in the host tissues and Loomis, Beck and Stauffer established that compounds toxic to this pest in corn are elaborated in the normal course of metabolism and at certain stages of growth are produced in concentrations high enough to be lethal. Walter found that the silks of some inbred selections of maize were toxic to the larvae of *Heliothis zea* (Boddie), and that the character could be transmitted by breeding. Comprehensive tests of sorghum for resistance to the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), carried out on 460 varieties, showed that a high level of resistence occurred in the Sudan sorghums; it was concluded that resistance in this crop involved both non-preference on the part of the aphid and antibiosis on the part of the host.

Preferences of the insect also play a part in determining the distribution of a population between different plant species within its natural host range. Population behaviour, or development, has been studied with particular reference to *Lymantria dispar* on different kinds of deciduous trees. It was found that the nature of the food plant affected the duration of development of the insect, and that is likewise apparently determined, at least in part, by the species of tree attacked. In an investigation of the food plants of *Circulifer tenellus* Baker it was found that the host species most commonly infested varied both within and between plant associations, and also differed at different times during the summer. The effects on fecundity of the quantity and quality of food ingested by females of *Leptinotarsa decemlineata* Say were studied in the laboratory. Fecundity was positively correlated with the quantity of food eaten, and with the age of the leaf tissue available. In further tests it was found that fecundity was positively correlated with the total choline content of the leaf. A study has been made of the effect of different insect hosts on the parasitoid *Bracon gelechiae* Ashm. The host was found to influence the rate of development of the parasitoid larvae, and the fecundity of females that subsequently emerged. Development and survival of parasitoid larvae in a single host species was found to be influenced by the nature of the food plant on which the host larvae had fed.

In an investigation of the effects of irrigation and application of fertiliser on three species of mirids attacking cotton, it was found that population differences between irrigated and non-irrigated plots became marked when plants in the latter began to show signs of water stress. The largest population developed on plots which had received both fertiliser and water, and the smallest on plots maintained without either.

In efforts to elucidate the factors controlling insect behaviour, constant records of activity have been made on pest species in several groups. Such studies, broadly, are still in the data-collecting stage, and conclusions are tentative. In a study of hoppers of *Nomadacris* it was considered that activities were triggered by changes in stimulation, and that the absolute levels of stimulating factors provide a background that merely limits the level of activity. In studies of mosquito behaviour, emphasis has been laid on recording the biting cycles of various species and on interpreting behaviour of the adult in relation to its developmental condition.

The following references are listed in the original article:

Activity (insect) studies	Rev.appl.	Ent.	Ser.A,	*47*:201.
Bacteria and insect control	"	"	"	*45*:381.
Diapause	"	"	"	*45*:55.
	"	"	"	*47*:33, 451.
Fecundity	"	"	"	*47*:352.
Fertiliser, effect on pests	"	"	"	*46*:121.
Food source relationships	"	"	"	*45*:31.
	"	"	"	*46*:262, 458.
	"	"	"	*47*:12.
Heat, effect on colour and weight	"	"	"	*47*:388.
effect on insect egg	"	"	"	*47*:132, 143, 186.
Humidity relations	"	"	"	*46*:145.
Infectivity, vector transmission	"	"	"	*47*:407, 484.
Irrigation, effect on pests	"	"	"	*46*:121.
Low temperature effects	"	"	"	*45*:93, 198.
	"	"	"	*47*:263.
Low volume spraying	"	"	"	*45*:460.
	"	"	"	*47*:373.
Maize, toxic to *Heliothis*	"	"	"	*46*:101.
Microbial products, standardisation	"	"	"	*47*:14.
Mosquito, biting cycles	"	"	Ser.B,	*47*:22, 79, 109, 150.
Olfactant studies	"	"	"	*45*:183.
Oviposition	"	"	Ser.A,	*46*:253.
	"	"	"	*47*:112, 153.
Parasitoid larvae and food plant	"	"	"	*46*:12.
Pest surveys (air)	"	"	"	*45*:100.
Pesticides,				
development of safer compounds	"	"	Ser.B,	*48*:25.
effect on beneficial insects	"	"	Ser.A,	*47*:14, 42, 66.
soil effects	"	"	"	*45*:63, 180, 408.
tainting of crops	"	"	"	*45*:8.
Photoperiodicity	"	"	"	*47*:230.
Radiation, effect on insects				
thermal induction,	"	"	"	*45*:252, 94.
gamma rays	"	"	"	*47*:130.
x rays	"	"	"	*45*:430.
Relation of host plant to attack	"	"	"	*46*:2, 122.
Repellent insect debris	"	"	"	*45*:210.
Resistance, Sudan sorghum to aphid	"	"	"	*46*:123.
Virus, transmission studies	"	"	"	*46*:125.
Weeds, control by insects	"	"	"	*40*:5.
	"	"	"	*47*:207.

ACHIEVEMENT AT KARIBA

The construction of the Kariba Dam, on a site in a remote area inhabited mainly by game and tsetse flies, and in face of almost unprecedented difficulties, was a magnificent achievement made possible by the success of the health service created for the project. Dr. M. H. Webster and his team deserve the warmest congratulations on its success.

Control of malaria, which was highly endemic locally, was the first measure undertaken. The interior walls of houses were sprayed regularly with residual insecticide, reinforced at first by applying oil to mosquito breeding places. The use of prophylactic antimalarials by European and African staff was obligatory. Only two Europeans died from malaria; both lived outside the controlled area and neglected chemoprophylaxis. Rhodesian sleeping-sickness also was present in the sparse local population and tsetse flies were very dense near by. Air-spraying of the fly's dry-season habitat together with block spraying of the living area, a total of 15 square miles (39 sq. km.), controlled tsetse for a year, by which time the growth of the project had driven away the game animals necessary for its survival. Reintroduction on vehicles was prevented by spraying chambers, and, on one busy road, by maintaining an insecticidal fog in a cutting. Only one case of trypanosomiasis occurred, a symptomless infection of unknown origin in an African.

Probably the greatest meance was the housefly. The high standard of sanitation necessary for its control was difficult to achieve owing to the very rapid expansion of the labour force. At first accommodation was primitive, but eventually townships for Europeans and Africans were constructed of concrete block buildings. The Africans were provided with communal ablution facilities and water-borne sanitation. Temporary quarters vacated were immediately destroyed to prevent occupation, and new houses were kept vacant until sanitary services were ready. An attendant was provided to instruct people in the use of water closets, and to keep them clean. At working sites chemical closets were provided. Water supply from the river was complicated by the variation of some 70 ft. (21 m.) in its level, so that the intake pumps had to be mounted on rails on a ramp.

Causes of morbidity were numerous. Gastrointestinal infections were rarely severe; all labour was inoculated against typhoid, paratyphoid, and tetanus. Heat cramp and exhaustion were common, especially among Italians, who, in place of their customary wine, drank beer rather than the saline drinks provided. Skin diseases were common resulting from sweating and dust, which contained much irritating micaceous material. Dust also caused respiratory-tract infection and eye complaints. Schistosomiasis and hookworm infections were treated on recruitment and gave little trouble. Salk-type vaccine was given to all European children after two had developed poliomyelitis. Injuries were the predominant cause of major and minor disability, and accidents were responsible for two-thirds of European and one-third of African deaths. A first-aid station was provided at the beginning, but later a hospital was erected, capable of dealing with almost every type of case. Hospital charges were borne by the employers.

This comprehensive health service cost less than £250,000 over a period of four years - that is, about 0.3% of the total expenditure on the Kariba scheme. In view of the high health standards maintained during construction the investment must be regarded as having paid handsomely. The description of these medical operations* will prove of great value to those planning large engineering projects in a tropical environment.

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* Webster, M. H., Cent. Afr. J. Med., 1960, *6*, Supplement pp 1-36.

(British Medical Journal, March 11th, 1961 p. 731 - 732)
We are indebted to the Editor of the British Medical Journal for permission to reproduce the above article.

AIRPORT SAFETY

One of the major safety problems facing the air transportation industry today is the task of ridding airports of nesting bird populations. Ingestion of birds into the engines of high-speed aircraft has resulted in at least one air crash in Boston and is a constant threat to air safety. Pesticides are considered a valuable tool in this problem, so reports the US Fish and Wildlife Service.

While there is no habitat, either natural or man-made that will not attract certain species of birds at some season of the year, the airfield and its vicinity can be rendered less attractive to those species of birds that form the potential hazard.

The proper use of selective weed killers to remove weeds and brush around airports and on the airports plus the addition of insecticides to the grassy areas of runways to control grubs and other soil inhabiting insects would reduce the attraction of the areas as a food source to birds.

(Oil, Paint and Drug Reporter, 13 March 1961, *179*, (11), 49).

DIETHYLTOLUAMIDE

Re-evaluation of all the available toxicological data on diethyltoluamide has been completed by the U.S. Army Environmental Hygiene Agency (formerly the U.S. Army Environmental Health Laboratory), and the above office has given toxicological clearance for diethyltoluamide to be used by the United States Army as the standard insect repellent for skin application to replace M-2020.

(Insecticide Newsletter, Ottawa. Dec. 1960, *9*, 12).

VETERINARY PEST RESEARCH IN THE U.K.

Systemic insecticides: In collaboration with the Veterinary Investigation Centres, a second field trial of the new systemic insecticide "Trolene" (now "Etrolene") was arranged at the Central Veterinary Laboratory, Weybridge. This compound originally known in the U.S.A. as Dow ET-57, has been shown to kill warble fly larvae during the early stages of their migration in the bovine. In the previous 1957/1958 trial, over 90% control was obtained, but in the 1958/1959 tests control was usually less than 90%. The apparently poor degree of control was partly due to the small numbers of warbles which appeared in the backs of the untreated cattle, making accurate assessment of control difficult.

Hypoderma lineatum larvae isolated from the oesophagi of infected cattle have been implanted into rabbits, guinea pigs and calves, and these infected animals used to test the effect of orally administered "Trolene" on the warble larvae. Rabbits and calves were suitable subjects for implantation experiments, but in several rabbit tests it was found that doses of insecticide far above the host LD 50 failed to kill all the implanted larvae. The work with calves is more promising and will be reported later.

"Trolene" is an organo-phosphorous compound and will inhibit the action of mammalian and insect cholinesterase. Blood samples from rabbits and calves have shown a gradual cholinesterase depression over the forty-eight hours following dosing with "Trolene". Using young blowfly *(Lucilia sericata)* and housefly *(Musca domestica)* larvae as indicators, the blood of treated rabbits and calves has been shown to contain toxic material (believed to be the oxygen analogue of "Trolene") one to six hours after dosing. Mosquitoes *(Aedis aegypti)* fed on rabbits and guinea-pigs which had been orally dosed with "Trolene" four hours previously showed heavy mortality, but none of the test insects were affected by blood taken more than sixteen hours after dosing, although blood cholinesterase levels were still low.

New Antidote: A new antidote to poisoning by organo-phosphorous compounds, pyridine-2-aldoximine methiodide (PAM) is being investigated. Unlike the standard antidote, atropine, PAM may be given before the onset of symptoms or even before dosing, when it will protect cholinesterase from inhibition by the organo-phosphorous compound. When given therapeutically, PAM reactivates the inhibited enzyme. It is hoped that work with adult insects and with implanted warble larvae in animals treated with "Trolene" will help in understanding the mode of action of this systemic insecticide.

Sheep blowfly - Rearing experiments: Experiments continued to determine the reason for an increasing sterility in fly colonies maintained in only artificial light. The duration of the photo-period, and the effect of two-side as against one-side illumination, were tested. No sterility was obtained, even after several generations.

A series of experiments has been carried out on the effect of cage factors, such as size, density, isolation, continuous presence of males, on the mating and reproduction behaviour of *L. sericata* flies, so as to produce standards for repetitive or comparative experiments. The effect of food type, age when offered a mate, and similar variables on results obtained with cage colonies has also been tested.

A detailed investigation is being made of the physical and physiological changes associated with insemination, and particularly of the role of an "accessory plug", the function of which is so far unknown, observed in the female after insemination. Present evidence suggests that it may have a bearing on the behaviour of the females in nature in relation to proffered second mating.

A historical examination of the sequence of events in development of the imago from the pupa is being made. Examination is being made of complete serial sections cut from each of more than twenty age-groups of pupae.

(Report on the Animal Health Services in Great Britain, 1959. Ministry of Agriculture, Fisheries and Food Department of Agriculture for Scotland, p. 49-57).

USE OF AIRCRAFT IN AGRICULTURE - CODE OF CONDUCT

A Code of Conduct is being introduced on a voluntary basis for a trial period of one year, at the end of which time it will be subject to review. It has been prepared by the Spraying and Aerial Spraying Committee of the National Association of Agricultural Constructors (N.A.A.C.) under the Chairmanship of Mr. F. W. Morris, after close consultation with the Ministry of Agriculture, Ministry of Aviation, the National Association of Corn and Agricultural Merchants and the National Farmers Union.

The object is to assist agricultural operators in maintaining "a high standard of discipline and sense of responsibility" and thus to secure exemption from the new Air Navigation Order.

Part I of the Code of Conduct contains 10 clauses relating to the responsibilities of Aerial Spraying Operators. These are, Pilot Training, Maintenance of Records, Low

Flying, Drift, Maintenance, Markers, Operations Manual, Fatigue, Crash Helmets, Use of Chemicals.

Use of Chemicals: This clause stipulates that operators will ensure that all flying personnel have studied notes on agricultural chemicals. When scheduled chemicals are being applied, all personnel employed upon the operation should be fully briefed on the nature of the product and the statutory precautions required under the Agriculture (Poisonous Substances) Act.

Part II which cites the responsibilities of Ground Organisations employing Aerial Operators is reproduced below:

Definitions

Aerial Operator: A Company (person or persons) owning and operating aircraft for the purpose of applying agricultural chemicals.

Ground Organisation: A company (person or persons) employing an aerial operator for the purpose of applying agricultural chemicals.

Agricultural Chemical: Any substance, insecticide, fungicide, herbicide, fertilizer, or similar item which is applied to agricultural land or growing crops.

1. The ground organisation should nominate one man who must assume full technical responsibility for the operation. The person nominated should have had a minimum one and a half years, to include two application seasons, practical experience of crop spraying, including details of aerial spraying, must have attended a course of instruction, and his standard of information should be such that he has full understanding of the crops to be treated, plus a knowledge of susceptible crops, of weeds, pests and other diseases in the crops, and of the chemicals being used.

2. The ground organisation should provide a written brief for the aerial operator for each job undertaken, the following detailed information to be included in the brief.

   (a) Crop and acreage to be treated, including map references.

   (b) Purpose of treatment.

   (c) Type of chemical to be used and whether statutarily regulated.

   (d) Quantity of chemical per acre.

   (e) Volume per acre.

   (f) Type of spray to be used - coarse or fine.

   (g) Flying hazards in any area including adjacent areas to be treated.

   (h) Possible danger to neighbouring crops where the chemical being used is either a scheduled poison or one which can damage a neighbouring crop if drift occurs, the use of this chemical must be authorised by the signature of the responsible person in the ground organisation and protective clothing must be worn.

3. The ground organisation should *make every effort* to:

(a) Locate livestock and survey fields adjacent to the area to be treated in case susceptible crops are growing in adjacent fields. Special care to be taken where drift of the chemical is likely to cause damage and advise farm employees working in adjacent fields.

(b) Locate all forms of livestock in the vicinity of the area to be treated, and inform the owner and present a clear brief to the aerial operator of the location of such fields and livestock.

(c) "Beekeepers should be informed when spraying operations are to commence" in accordance with the warning scheme operated by the Ministry of Agriculture.

(d) "Beware of poisoning fish by contaminating rivers and streams."

4. Herbicides will be applied from the air only after all parties concerned, namely the aerial operator, the ground organisation and the farmer, have satisfied themselves beyond reasonable doubt that they can be applied without damage to neighbouring crops or property. Particular attention will be paid in cases where it is intended that hormone weed killers will be used.

5. The ground organisation should ensure that:

(a) Unauthorised members of the public and farm stock are not allowed in the filling-up area until all spillage and contaminated foliage has been covered up.

(b) Operators follow the precautions suggested by the manufacturers, especially as regards protection clothing, puncturing and burying containers and burning of paper bags, ensuring that they are not left lying around for animals and children to get them.

6. The ground organisation should maintain a record of the area (property) treated, showing the date and time of each operation and the direction of wind at the time of application and the nature of the materials used. This record to be signed by the pilot and counter-signed by the ground organisation and the record to be retained in the area of operation for a minimum period of two years, and be available for inspection by N.F.U. county secretaries. This record may be regarded as replacing that to be maintained by an aerial operator under Clause 2 of the proposed Code.

7. The ground organisation to be responsible for giving Notification in general terms to the police of the areas in which agricultural operations involving low flying aircraft are taking place, and the aerodromes being used. This shall in no way replace the legal obligations currently incumbent upon the aerial operator under the Air Navigation Order.

8. The aerial operator and the ground organisation shall maintain adequate insurance to indemnify the grower and third parties for all claims including crops being treated arising out of the negligence of the aerial operator or the ground organisation.

Note

Where the operator deals direct with the customer the operator accepts full responsibility for the implementation of all clauses of the Code of Conduct for the ground organisation.

All clauses in this code are the responsibility of the ground organisation.

THE AGRICULTURE (POISONOUS SUBSTANCES) AMENDMENT REGULATIONS, 1961

Made	29th March, 1961
Laid before Parliament	5th April, 1961
Coming into Operation	6th April, 1961

SCHEDULE

Part I

Common Name	Substance
-------	S-(3, 4-dihydro-4-oxobenzo-(1,2,3) triazin-3-yl) methyl 00-dimethyl phosphorothiolothionate.

Part II

Common Name	Substance
-------	6,7,8,9,10, 10-hexachloro-1,5,5a,6,9,9a-hexahydro-6, 9-methano-2,4,3-benzo(*e*) dioxathiepine 3-oxide.

Part III

Common Name	Substance
azinphos-methyl	S-(3, 4-dihydro-4-oxobenzo[d]-[1,2,3]-triazin-3-ylmethyl) dimethyl phosphorothiolothionate.
ethion	tetraethyl SS'-methylene bis(phosphorothiolothionate).
mecarbam	S-(N-ethoxycarbonyl-N-methylcarbamoylmethyl) diethyl phosphorothiolothionate.
phenkapton	S-(2,5-dichlorophenylthiomethyl) diethyl phosphorothiolothionate.

Note:

By virtue of the Agriculture (Poisonous Substances) Regulations, 1956 to 1960, workers to whom those Regulations apply may not, and their employers may not cause or permit them to, carry out certain scheduled operations with substances specified in those Regulations unless the prescribed safety measures, including the wearing of protective clothing are observed.

These Regulations add to the poisonous substances so specified four further poisonous substances:-

(1) a substance bearing the trade name "Thiodan";
(2) ethion;
(3) mecarbam; and
(4) phenkapton.

The first of these substances is included within the group to which the Agriculture (Poisonous Substances) Act, 1952, was extended by the Agriculture (Poisonous Substances) (Extension) Order, 1960 (S.I. 1960/398). The other three substances are organo-phosphorus compounds.

In addition, the substance known by the trade name of "Gusathion, which now has the agreed common name of azinphos-methyl, has been transferred from Part II to Part III of the Second Schedule to the 1956 Regulations (as amended).

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE IN GREAT BRITAIN

Recommendations, for safe use in agriculture and horticulture of the compounds noted below, have recently been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Chemical	Poison Classification	Date
Demeton-Methyl	Second Schedule, Pt.III.	Revised: April 1961.
Endothal	Second Schedule, Pt.II.	Revised: March 1961.
Mecarbam	Second Schedule Pt.III.	Issued: February 1961.
Mecoprop	Not Scheduled.	Revised: April 1961.
Metiram	Not Scheduled.	Issued: March 1961.
Phenkapton	Second Schedule Pt.III.	Revised: February 1961.
Phosphamidon	Second Schedule Pt.III.	Revised: February 1961.

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

PESTICIDE SYMPOSIUM

A two and a half day symposium on the analysis, degradation and metabolism of pesticide residues has been arranged as Section C3 of the Analytical Chemistry programme of the 18th International Congress of Pure and Applied Chemistry, to be held in Montreal in August, 1961. The symposium will be held on August 7th, 8th and 9th. The chairman and co-chairman are Dr. H. Hurtig and Dr. E. Y. Spencer of the Research Branch, Canada Department of Agriculture.

The sessional lectures will be given by *Dr. R. D. O'Brien*, (Cornell, Ithaca, U.S.A.), "Molecular configuration and activity of pesticides as related to degradation and metabolism", *Mr. F. P. W. Winteringham* (Pest Infestation Laboratory, Slough, U.K.), "Tracer techniques for determination of the chemical fate of insecticides", *Dr. S. Dormal* (Centre de Recherches de Phytopharmacie Gembloux, Belgium), "Comparative methods of residue analysis", and *Dr. S. E. Westlake* (U.S.D.A., Beltsville, Md. U.S.A.), "Objectives and progress in regional pesticide residue projects in the U.S.A.".

Twenty-four other invitation papers and contributions will be presented by speakers from the U.S.A., France, England, Italy, Yugoslavia and Canada.

For further details write to:

The Secretary, Central Committee,
XVIIIth International Congress of
Pure and Applied Chemistry,
National Research Council,
Ottawa, 2, Canada.

NEWS ITEMS FROM THE U.S.A.

(1) **Microbial Bait:** The tobacco budworm, an insect that attacks tobacco plants, can be controlled by applications of bait containing dried spores of *Bacillus thuringiensis*. The bait consisting of corn meal and spore, applied by hand to the growing tips of tobacco plants, controlled both budworms and horn worms in experiments conducted in 1960. It has been shown to be just as effective or more effective than the best chemical insecticide spray (endrin) now used in preventing hornworm and budworm damage to tobacco plants. The bacterium is harmless to warm-blooded animals including man.

Hornworms stop feeding soon after they eat the treated bait. The bait consist of one part of *B.* thuringiensis (90 billion spores per gram) to 99 parts of cornmeal, applied bi-weekly in four applications at the rate of about 12.5 pounds of the bait per acre for budworm control.

Note 1. In the tobacco-growing areas of the United States, hornworms cause more damage to tobacco than any other pest. Total damage by hornworms is estimated at $80 million annually.

Note 2. *B. thuringiensis* was first studied and described in 1911 by a German entomologist after it had been found in a shipment of Mediterranean flour moths from a flour mill in Thuringia, Germany. The bacillus was tested and found to be effective as a biological control agent against the alfalfa caterpillar in California in 1951. Since then it has been used experimentally by several State and Federal research entomologists for the control of many insect pests.

(U.S. Dept. of Agriculture, Press Release 277-61).

(2) **DDVP:** The insecticide DDVP featured in two papers (1), (2), presented to the 46th Meeting of the C.S.M.A. Dr. Tracy referred to DDVP as an unusual, unique insecticide, describing its most apparent properties by the remark "you put it on the floor and the flies die on the ceiling". He felt that it was not a well understood insecticide yet one which possesses some excellent and desirable properties.

On its vaporization: "Although the vapour pressure of DDVP approximates 0.1 mm at 30°C., volatilization is such that about 2% to 0.7% of the total dose of DDVP is in the air several hours after application. Data in Table 1 show the air concentrations of DDVP in a closed barn treated with 6 gm of the chemical in water sprinkled on the central walkway. The rate of application was 0.5 mg DDVP per cu.ft. The values for air concentrations agree satisfactorily with those obtained in tobacco warehouses by Durham *et al.* and in steel drums by Tracy.

Because DDVP volatilizes, it is necessary to consider the volume of treated areas rather than the surface areas alone, as is done with most insecticides. In fact, the volume used of a 0.5% or 1.0% DDVP spray should be sufficiently precise so that not more than 1 gram of DDVP is applied in 2,000 cu.ft., unless a greater concentration is specifically required and special precautions or methods are exercised in the application.

DDVP is not a true fumigant in the sense of the lighter gases, such as HCN or methyl bromide. The molecule is relatively heavy, having a molecular weight of 221. It is probably for this reason that its fumes have poor penetrating powers. DDVP vapours do not penetrate into tobacco packed in hogheads nor into bulked grains of sacks containing spices and other substances. Just recently Dierberger in Brazil, found that DDVP vapours failed to penetrate piles of bagged coffee beans even though 10 mg. DDVP per cu. ft. was applied in the closed warehouse and examination was made 48 hrs. later. Only about 50-86% kills were obtained in the tests, although the adult coffee bean borer is known to be susceptible to DDVP vapour.

It is expected that DDVP vapours are readily adsorbed onto surfaces, but are released more slowing than are the light gases. This effect was noted by Durham *et al.* in a Hazelton chamber, and in our laboratory on gunny sacks used for wrapping Turkish tobacco.

One significance of this behaviour is that considerably longer residual action can be obtained under certain conditions than is commonly conceded for DDVP. Usually, DDVP sprays are effective for 1 to 5 days after application, whereas some adsorbent materials treated with DDVP may remain insecticidal for three to four weeks.

Such chemical behaviour obviously requires that pest control operators give conscious consideration to vapour adsorbtion on various objects when DDVP is used in closed areas or in restaurants and homes. In other words, overdoses of DDVP should be avoided even though it may seem that "a little more is better".

TABLE I

Concentrations of DDVP in the Air of a Closed Stable Treated Daily with 0.5 Mg. DDVP per cu ft.

Days Stable treated	Air Sample hrs. after DDVP applied	Conc. DDVP Micrograms per litre air	% DDVP in air
11	2-3.5	1.390	7.8
11	12-13.5	0.357	2.0
12	22-24	0.240	1.4
22	2-3.5	1.490	8.4
22	22-24	0.350	1.9

On its insecticidal concentrations: "As with most insecticides, the LD_{50} and LD_{100} of DDVP varies with different insect species and the method of application (topical, oral or injected). The lethal respiratory dose seems to be somewhat greater than the oral dose. Metcalf *et al.* found the toxic dose of DDVP vapours for house flies was nearly three times greater than the topical dose, 0.057 to 0.02 micrograms. In our stable tests with DDVP applied on the floor at the rate of 0.5 mg. per cu.ft., it was found that *M. domestica* L., the stable fly, and other Diptera were killed within two to five hours, whereas German cockroaches and cigarette beetles and flies were killed within 4-5 hours, although 50% of the roaches survived 24 hours' exposure. At 2 mg. DDVP per cu. ft. the three insect species were killed within 18 hours' exposure. By direct contact with a 0.5% emulsion of DDVP, biossays indicated that all three species were killed within 20 hours by 1 - 2 micrograms of DDVP.

Metcalf attributes the insecticidal activity of DDVP to its anticholinesterase activity, and Arthur and Casida suggest that in the Ch E blocking process an inert dimethyl-phosphoryl enzyme is formed".

On its toxicity: Figures given indicate that the liver is an important centre for detoxication of DDVP in the mammal. Furthermore, it is clear from the tests that DDVP is not stored in animal tissues, nor are toxic metabolites produced from DDVP.

It is apparent that the hazard of DDVP is related to the amount of acute intake rather than to accumulation in body tissues from repeated exposures or to metabolic deviation of the DDVP molecule in the animal body.

(The oral LD_{50} in female rats has been established as 60mg/kg; intraperitoneal LD_{50} as 6 mg/kg; dermal adsorbtion LD_{50} in xylene as 75 mg./kg.)

Use in Aircraft: Dr. Schoof referred to its use for aircraft disinfection "Recent studies with DDVP vapour (Maddock *et. al.* in manuscript) introduced into the ventilating system of intercontinental aircraft showed that 95 to 100% kill of houseflies distributed through the passenger compartment could be obtained with an exposure period of 30 minutes and a concentration of 0.11-0.35 microgram of DDVP vapour per litre of air. The application of the insecticide in this manner offers considerable promise as a means of killing insects in aircraft, whether they are hidden beneath seats, in closets, or at other semiprotected sites. At the same time, it relegates the dispensing of the insecticide to a mechanical procedure in which crew participation could be limited to the pushing of a toggle switch.

Other Conference papers were given by J. T. Coyne, (3) M. P. Jones, (4) H. L. Haynes (5), L. K. Cutkomp, (6), J. Dreessen, (7), G. Coombs, (8), and C. F. Gordon, (9).

References:

(1) Experiences with the Insecticidal and Toxicological Properties of 0,0 Dimethyl 2,2-Dichloro Vinyl Phosphate.

(2) Recent Advances in Chemical Control of Medically Important Insects.

(3) Developments in the Administration of Public Law.

(4) Visual Aids in Household Insect Control.

(5) Garden Pesticides.

(6) Radioactive Tracer Work to Determine Possible Residues in Milk and Meat from Dairy Sprays.

(7) Weed Killers and Public Reaction.

(8) Pesticide Formulation: A Carrier Producer's Viewpoint.

(9) Analysis of Milk from Cows Sprayed with Lethane 384.

(Proceedings of the Chemical Specialities Manufacturers Assoc. Inc., 46th Mid. Year Meeting. May, 16, 17, 18, 1960.). Drake Hotel, Chicago, Illinois. Published by CSMA, 50 East, 41st Street, New York 17, N.Y.).

3. **Aircraft Disinsectisation:** An automatic (remote control) aerosol dispenser for aircraft disinsectisation has been developed by U.S.D.A. researchers. Each dispenser is designed to treat 1000 cu.ft of space. Sprayers are distributed to apply dosages evenly and exactly. For many years planes have been sprayed by hand, with push button-type aerosols, upon entering the United States to prevent introduction of undesirable insects. This hasn't always been effective, because hand-spraying is uneven and doesn't reach all parts of a plane.

The new device killed all caged and free-flying yellow fever mosquitoes in a 2,000 cubic-foot fuselage. Researchers used 100 milligrams of allethrin per 1,000 cubic feet.

(Agricultural Research, Feb. 1961, 9, (8), 14.).

(4) Pesticide Residues Control: "The recommendations of the Entomology Research Division, Agricultural Research Service, as of January 1st, 1961, for the chemical control of insects and mites that attack food, feed, tobacco, and fibre crops and livestock are presented in a revised edition of the Handbook for 1961.* The information was compiled by the various Branches of this Division in consultation with the Pesticides Regulations Branch of the Plant Pest Control Division and the Federal Extension Service.

It is emphasized that these recommendations are those made by the Entomology Research Division. They are intended as a guide for entomologists, other research and extension workers, and various agricultural associations and agencies, rather than to provide information for individual farmers. These recommendations do not apply necessarily to all areas or parts of the U.S.A. There are other recommendations and other materials registered for use that will meet the requirements of the Federal Insecticide, Fungicide, and Rodenticide Act and the provisions of Public Law 518, the Miller amendment to the Federal Food, Drug, and Cosmetic Act.

Tolerances for some insecticides have not yet been established by the Food and Drug Administration, and previously established tolerances are occasionally reconsidered and modified. As new tolerances are established or changes made, the Department will review the recommendations and modify them as needed to insure that residues do not exceed the tolerances.

(5) Pesticide Residues in Meat & Milk: Studies were conducted at Kerrville, Texas, to determine whether insecticides used on livestock, or on pasture and forage crops will contaminate meat or milk, and if residues are produced, how long they will persist.

Single spray treatments of DDT, TDE, and methoxychlor applied at 0.5% concentrates to beef cattle caused storage of the insecticide in the fat. Lindane at a concentration of 0.03% could not be detected, but at a concentration of 0.075% both sprays and dips caused residues in the fat. Multiple-spray treatments at 2 - or 3 - week intervals with other chlorinated hydrocarbon insecticides—chlordane, gamma chlordane, DDT, dieldrin, heptachlor, TDE, "Strobane", and toxaphene resulted in slight-to-moderate increases in the amount of storage. A 0.5% malathion spray applied at weekly intervals caused no storage in the fat.

When insecticides were fed to beef cattle and sheep as a contaminant of their feed at dosages likely to occur as residues on forage crops, all except methoxychlor were stored in the fat. The order of their storage was as follows: aldrin > dieldrin heptachlor epoxide > BHC > DDT > chlordane > lindane > endrin > heptachlor > toxaphene.

All the chlorinated hydrocarbon insecticides, "Co-Ral", and malathion were excreted in the milk of dairy cows following the spray treatments. Rotenone was not excreted in the milk and "Co-Ral" was present in very small amounts. Dieldrin caused the greatest contamination, followed in order by DDT, TDE, "Dilan", toxaphene,

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* United States Department of Agriculture insecticide recommendations of the Entomology Research Division for the control of insects attacking crops and livestock for 1961. Revised March, 1961, pp. 138.

"Strobane", methoxychlor, "Perthane", malathion, and "Co-Ral". When "Sevin", "Dicapthon", and "Bayer 22408" were fed to dairy cows as a contaminant of their feed at dosages in excess of those likely to occur on forage crops, residues of these insecticides were not detected in the milk.

(Pesticides Residues in Meat and Milk, - A Research Report U.S.D.A. Agric. Res. Serv. ARS-33-63 December 1960.).

(6) Research at American Universities

(a) Georgia experiment station

Nematode Control:

Tobacco: The efficiency of control of root knot nematodes by various soil fumigants and their effects on tobacco quality have been studied for the past several years. It is important that soil fumigants be carefully tested because of their possible effect on leaf composition. Without going into detail the most satisfactory control has been secured by the use of "D-D" mixture, "EDB-40", "Telone", and "Dorlone". Some experimental nematocides which may prove to be superior are now under test, but their effect on leaf composition has not been determined to date.

Other Crops: Georgia scientists are constantly studying the occurrence of various nomatodes on various plants in Georgia and are working out control measures. The importance of nematode control is shown in its contribution to increased per-acre crop yields as follows:

Snap beans, 2133 lbs; field corn, 27 bushels; seed cotton, 1761 lbs; okra, 5½ tons; and peanuts, 1400 lbs. These large increases were made on heavily infested soils.

Peach Spray Schedule:

Plum curculio are now under control in Georgia peach orchards due to the development of the parathion-sulphur spray programme which replaces the old lead arsenate spray schedule. Parathion also effectively controls scale insects, oriental fruit moth, and peach tree borers. Testing programmes in Georgia Experiment Stations also indicate that captan is the most outstanding fungicide tested, being equal to or superior to sulphur, in control of brown and rhizopus rots.

Residue tolerances: Controls for numerous insects have been developed. Based on recommended (FDA) rates per acre, tests conducted during a three-year period show that:

Malathion may be used on alfalfa, pimentos. and grain sorghum; toxaphene and DDT may be used safely on pimentos; aldrin may be safely recommended for control of soil insects attacking sweet potatoes.

(A Decade of Progress, in serving Georgia through Research. Annual Report 1960, University of Georgia, College of Agriculture Experiment Stations).

(b) Mississippi Agricultural Experiment Station

Control of Cattle Pests: The use of several new livestock systemics insecticides for cattle grub control continued to appear promising. The feeding of "Trolene", "Dimethoate" and "Dipterex" to Hereford steers resulted in the following respective reduction of grubs: 95%, 26%, and 59%. No toxic reactions followed the feeding of these materials during the past season. Mid-season (July) treatments of steer calves with "Co-Ral" spray, "Reulene" drench and "Dylox" drench were most effective in the order listed; "Co-Ral" was 100% effective.

A 25% methoxychlor dust in dairy backrubbers gave horn fly protection for 24 days compared to 5.5 days for "Korlan" and 8 days for rotenone. Shaker methods of application of the dusts to dairy animals proved superior to back-rubber methods.

Rice Insect Control: Rice is a valuable crop in the Delta area which aids in supporting a balanced agricultural programme. Some very promising results have been obtained toward controlling the various insect pests which affect growing rice. A bacterial formulation had little effect on the rice stink bug, but several of the organic chemicals had a high level of effectiveness. Parathion, "Ethion", "Dimethoate", and "Shell 3562" gave perfect control within 24 hours after treatment. Less spectacular results were obtained with toxaphene, dieldrin, malathion, and "Sevin". On the basis of completed tests, toxaphene is cheaper and gives good control. Excellent results were achieved with "Sevin", but a better formulation is needed to merit widespread use. Experiments are being conducted on rice water weevil control. Treatment of seed with chemicals appears to be the best approach, but other avenues are being investigated.

Sorghum Insect Control: Lack of uniformity was again found to be a serious drawback to sorghum grain production due to insect damage. It was found that by clipping a young planting with a wide spread in seedling emergence, a much more uniform regrowth resulted. It is felt that this may be accomplished at nearly any stage of development, if plants can mature before frost and there is adequate moisture. Plants can sustain about 15% loss of seeds before any yield is lost, because the remaining seeds develop greater weight per seed. "Sevin" was the only insecticide tested that showed promise.

(Mississippi Agricultural Experiment Station, 73rd Ann. Rep. 1960.)

AUSTRALIA - NEW SOUTH WALES

Field Crop Pests

Australian Plague Locust *(Chortoicetes terminifera):* Until spring, 1958, locust activity had been at a minimum for several years. During and since November, 1958, widespread locust activity has involved the major part of the Central Division, the Hunter River Valley and extensive areas in the Western Division. Various field trials and further progress have thus been possible in the development of an aerial spraying technique.

An experimental aerial spraying campaign was carried out in the Bogan-Castlereagh River area during March, 1958, in cooperation with officers of the Pastures Protection Section. Preliminary field investigations in January indicated a definite flight pattern in the first locust generations. This was supported by observations on the second generation in March. Topography of the area was found to be intimately related to swarm movement, and the importance of river systems in directing and concentrating swarms was established. Regular paths followed by major swarms were termed "driftways", and the aerial spraying tactics were based on the supposition that swarms can be intercepted and treated economically mainly at key points on these driftways.

A total of 5,100 gallons of 7% BHC concentrate was applied by two independent spraying units, each comprising a Tiger Moth spraying aircraft and an Auster scouting aircraft. Total cost of the campaign was approximately £13,000. Kills in the dimension of 100,000 locusts per gallon of 3.5% BHC applied, were obtained. The campaign was only partially successful in preventing swarm movement into other districts and did not prevent egg laying in the area.

Extensive egg laying has occurred in all infested districts and, as only very restricted hatchings have been reported the bulk of these eggs should overwinter in the ground and represent a potential threat in the spring of 1959.

Parasitism by the egg parasite *Scelio fulgidus* and the fly parasites *Locusticora pachytyli and Trichopsidea ostracea* has been observed, but the overall effect on the next generation is not known.

Flood conditions during late March and April, 1958, may have affected the viability of eggs in some areas. However, providing favourable conditions prevail during September, October and November a full scale plague is expected next spring over the greater part of the infestation area in N.S.W.

White-fringed Weevil *(Pantomorus leucoloma):* This is now being reported from more and wider areas, lucerne being concerned in most cases. The pest must now be rated amongst the State's most serious.

Further examinations of the soil growing a Ladino white clover dominant pasture on irrigated river flat country near Wingham, have revealed that the area (treated in January, 1958, with a dieldrin spray using 3 lb. active ingredient per acre, followed immediately by heavy irrigations up till the last observation in February, 1959), was entirely free from *Pantomorus* larvae, compared with fairly substantial numbers in the untreated area right alongside.

Treatments with aldrin, 3 lb. active ingredient per acre, and dieldrin, again at 3 lb. active ingredient per acre, applied in the same manner as before, in September, were noticed to kill adults as they emerged in December. The observations indicate a residual effect lasting at least three months.

Aldrin at 2 lb. active ingredient per acre, and a mixture of aldrin and heptachlor at 1 lb. active ingredient per acre, for each insecticide, applied in December, each gave a very good initial kill of emerging adults.

Amnemus Weevil *(Amnemus quadrituberçultatus):* In the last 12 months little progress has been made towards control. Further laboratory studies and field observations have clarified the life-history, habits and other aspects of its general biology.

Field control experiments in 1956-57 and 1957-58 show that:-

(1) Insecticides, mixed with fertilizer, and sown with the seed when sod seeding, affected the nodulation of subterranean clover; the effects with BHC and high dosages of DDT were drastic; that of aldrin, dieldrin and chlordane less severe.

(2) Some insecticides, notably dieldrin, aldrin and chlordane, were valuable in protecting seedling clover in newly sod seeded pastures, from insect pests such as crickets and caterpillars.

In addition, life-history studies and field observations had shown that control measures could best be introduced in January or February, to correspond with the period of maximum adult activity; and prior to intensive egg laying.

The major problem of field control was unresolved, in spite of the testing of most insecticides with a favourable reputation against members of the weevil family.

All previous work, therefore was reviewed before the season's programme was designed, in an effort to resolve possible defects in control techniques, such as the design of experiments and the methods of application.

Eight experiments were set up in Wollongbar, Kyogle and Murwillumbah districts, located in irrigated and dryland pasture of ladino, red or subterranean clover with a record of *Amnemus* infestation. A spray boom was used to apply all insecticides. All experiments were designed to include large buffers around individual plots; treatments were replicated where possible. Insecticides and rates:- Aldrin ¾-4 lb. active ingredient per acre; dieldrin ½-3 lb; DDT 5-10 lb; heptachlor 4 lb; thiodan ½-4 lb.; BHC ½-2 lb. gamma.

Black Soil Scarab *(Othnonius batesii):* The known area of distribution of this insect was further expanded by reports of damage in a number of additional districts during the year and there is so far no indication of any abatement of the problem in the districts where this insect has been known. Damage was obscured to a large extent during the late summer and autumn, due to abundant rainfall stimulating a lush growth of herbage and grasses of all sorts.

Summer pastures and crops which might normally succumb to scarab larvae in drier seasons were able largely to outgrow such attack and some very heavy stands of Columbus grass *(Sorghum almum)* were grown on heavily grub-infested soils. However, late in the season, and with the onset of dry weather, the effects of grub attack became very evident; and summer crops, pastures, and sown winter cereal crops all experienced attack and damage.

Good progress was made in determining some aspects of the biology of this pest, with studies on eggs, larvae and pupae.

The 1958-59 flight season of adults extended from mid-December to early January. The average number of eggs present in the female reproductive system was 24.6. Two "forms" of females are in evidence, "juvenile" and "adult". Juvenile females show no interest in flying and have very poorly developed, or no wing muscles. They appear to be specialized for the "vegetative" exploitation of present resources. Adult females have very well-developed wing muscles and attempt to fly. This form, although produced in the juvenile habitat, is constitutionally unable to stay there, and is better fitted to exploit the "vegetatively" less favourable conditions in the species' geographic territory.

Production of adult females appears to be governed by a "stress" factor operating in or on the population, this form only occurring in patches which have a high population density. The number of eggs per female reproductive system for the two forms are: Juvenile, 28.03; Adult, 13.36.

Two biological factors received closer study this year: namely, an unnamed Thynnid wasp and a species of *Cordyceps* fungus, each of which has come to notice frequently. What part each plays in regulating the population density remains to be seen.

Some extensive control trials with insecticides have been laid down but results are difficult to interpret at present. Several materials show some promise but further information is needed on their effect on grub numbers and pasture composition.

Wheat Root Scarab *(Anodontonyx noxius):* Damage by larvae of this insect in winter cereal crops was again reported from light red soils in a number of localities. Exploratory trials last season at Tamworth showed for the first time, very spectacular control by using certain insecticides at sowing - in land where even heavy populations of larvae are known to be present.

Diazinon, aldrin, dieldrin and thiodan appeared to be the insecticides of choice. Further investigations are being carried out this season to evaluate these materials, especially in regard to practicability and cost.

Pruinose Scarab *(Sericesthis pruinosa):* Assessment of results of trials carried out to investigate control of this pest in the Dorrigo district have indicated that neither dieldrin, diazinon, thiodan, BHC, DDT or parathion gave significantly better results than occurred in untreated plots.

Pasture Cockchafer *(Aphodius tasmaneia):* In experiments at Orange, good control of this pest was obtained with BHC at rates of 2 oz. to 4 oz. per acre applied by a spinner type fertilizer spreader or by combine, although the former did not give quite such complete coverage. Observations also indicated that 4 oz. lindane per acre gave protection of an area in the year following application.

Bloodworms *(Chironomidae):* Until recent years rice growers in the M.I.A. have enjoyed almost complete immunity from insect pest losses. However, bloodworm infestation has built up strongly. It is now causing some loss, and considerable expense in control measures. During the past season considerable early losses and trouble in a number of areas, necessitating re-sowing, were occasioned - through bloodworms damaging the crops before application of irrigation water. Control measures have comprised drying out the bays, dripping on insecticides at the head of the bays or dusting the seed with insecticide before sowing.

Good results were obtained last season by boom spraying the area to be sown with dieldrin shortly before sowing.

Investigations will be commenced during the coming season to determine the actual role of bloodworms as a pest of rice; and to test the efficacy of a number of insecticides as seed dusts and for presowing application.

Black Beetle *(Heteronychus sanctae-helenae):* Large beetle populations observed during the late summer and autumn of 1958 led to the expectation that overwintered beetles would cause severe and widespread damage to spring sown crops. Due probably to the continuance of cool conditions into October, only brief minor swarmings took place. Little damage occurred in the Tweed district but several sugar cane plantations were attacked in the Lower Clarence River district. Growers generally obtained satisfactory results from the use of BHC dusts.

Monolepta beetles *(Monolepta australis):* Extensive swarms of beetles attacked silking maize crops in the Tweed and Richmond districts in December and January, and severely reduced pollination in many crops.

Knapsack dusting with DDT, BHC, DDT - BHC combination, or dieldrin, was relatively ineffective against repeated invasions.

Cob protection was achieved by individual farmers, with dieldrin or DDT-oil mixtures applied with knapsack fog or misting machines. These units afforded a practical means of treating large areas quickly, and the insecticide-oil mixtures gave excellent contact-kills. They had an effective residual action against subsequent infestations for three to four days. Severe defoliation of peanut crops occurred at this time in the Richmond district.

Lucerne Flea *(Smynthurus viridis):* During September, reports of damage to young lucerne stands were received from the Junee and Wagga districts. Experiments to assess some of the organophosphorus insecticides against this pest showed that "Gusathion" or diazinon, at 1 oz. per acre, plus malathion at 2 oz. per acre, gave high initial mortality; but newly-hatched fleas appeared subsequently on the treated plots, and follow-up treatment would be necessary. "Trithion" was shown to be of no value against this pest.

Heliothis caterpillar *(Heliothis spp.):* Lucerne crops, especially in the areas around Inverell, Warialda, Graman and Ashford, were heavily infested by these caterpillars during late summer. Flowers and lucerne seed pods were severely damaged.

Aerial spraying, using DDT, was effectively carried out over large areas. Good control was obtained. Following overcast, showery conditions an epizootic occurrence of virus granulosis practically wiped out the populations.

Leaf-hoppers *(Jassidae):* Very heavy infestations of leafhoppers severely damaged seedling lucerne crops in many parts of the State during the summer months.

Red-Legged Earth Mite *(Halotydeus destructor):* Extensive infestations occurred over large areas, in pastures, lucerne and cereal crops. Many thousands of acres were treated against this pest.

Investigations connected with lucerne flea control incidentally demonstrated that malathion was of no value in controlling the red-legged earth mite. "Gusathion" gave a rapid initial kill of mites, but diazinon and "Trithion" gave little promise. It was noted also, that sparsely vegetated areas, as for example, in a newly-germinated lucerne stand treated with DDT may be rapidly re-infested by mites invading from nearby heavily-infested untreated areas.

Pea Mite *(Penthaleus major):* Extensive air [illegible] spraying was carried out in north-western districts. There, this pest attacked and damaged many acres of young oat crops, also wheat, lucerne and pasture.

Vegetable Pests

Potato Aphid *(Macrosiphum euphorbiae):* Tomatoes of the variety Rouge de Marmande were heavily infested with this aphid on the north coast in the July-September period, 1958. Routine application of DDT, for control of *Heliothis*, was relatively innefective against the aphid — and separate aphicidal sprays of lindane or nicotine sulphate were required.

Oil Misting for Vegetable Pest Control: Oil misting as a means of pest and disease control in tomatoes, beans and cucumbers was preliminary tested as a joint experiment with the Biological Branch at Gosford. Two types of misting equipment were used, viz., "Fontan" and "Micronette", and insecticide plus fungicide, in agricultural misting oil, were applied.

Fruit Pests

DDT is no longer uniformly effective against codling moth, and DDT resistance has been confirmed in strains of codling moth from the Bathurst area. There now appears to be a considerable degree of resistance to this insecticide in many orchards throughout New South Wales and probably a degree of resistance in most blocks.

Fortunately, some insecticides are now available which may be substituted effectively for DDT in the spray schedule; but many of these suffer from lack of residual effectiveness and are not as good as DDT at its best; however "Gusathion" and "Sevin", extensively tested in recent seasons give promise of effectiveness as great as DDT.

"Gusathion" may be regarded as a complete insecticide for summer control of apple and pear pests. It will be top recommendation during the coming season. Whilst it is effective for control of codling moth, light brown apple moth, red spider and mites, it suffers the disadvantages of high toxicity and heavy residue.

"Sevin", which has out-performed all other materials tested with the exception of "Gusathion", is a safe insecticide. It controls both codling moth and light brown apple moth, but is not effective against red spider. The element of insecticidal resistance developing is ever present, but possession of Gusathion and Sevin, two such powerful insecticides of widely different composition, should postpone for a worthwhile period the development of such resistance.

Light Brown Apple Moth *(Tortrix postvittana):* The importance of this as a pest of deciduous fruits has developed only since replacement of lead arsenate by DDT in some fruit spraying programmes. In the past season it caused considerable trouble in certain areas, and poor control was reported on a number of occasions where TDE spray programmes (which had been found specifically useful for control of this pest) had been applied.

Experimental application of TDE and "Sevin" late in the season, when larvae in all stages were present, failed to give any appreciable control; but programme applications, during the season, of TDE, "Sevin", or "Gusathion", gave very satisfactory control.

The organo-phosphorus materials, "Ethion", "Delnav", and "Trithion" were not promising.

Red Spider *(Tetranychus telarius)*: Conditions did not favour severe red spider development; although infestations built up in some orchards, especially where DDT sprays were used.

Programmes of organo-phosphorus sprays gave generally good control of red spider, although some cases of presumed resistance were encountered. "Kelthane" gave very good control in all instances including those where presumed phosphate resistance was considered.

Fruit Tree Moth Borer *(Cryptophasa unipunctata)*: Observations indicated that occasional first year workings could appear as late as June. DDT miscible oil painted round the entrance to the larval tunnels did not give fully satisfactory control; a small percentage of borers surviving. DDT emulsion injected into holes gave complete destruction.

Citrus Gall Wasp *(Eurytoma fellis)*: It continues to be reported from further localities in the County of Cumberland and coastal areas north of Newcastle, but no significant development has been observed in any of the main commercial citrus-producing areas.

A preliminary screening trial of insecticides was carried out at Oxford Falls, using clean transplanted lemon stocks. These were sprayed at various times, during the wasp emergence period in October-November, with a number of insecticides at a common concentration of 0.1% of the active ingredient. Owing to variability of shoot development, results were inconsistent; but only a few materials showed promise, viz., "Phosdrin", "Metasystox", "Metaisosystox" and "Trithion". Unpromising materials were "Gusathion", "Ciba 570", parathion, diazinon, "Thiodan", endrin, dieldrin and malathion-oil.

Banana Beetle Borer *(Cosmopolites sordidus)*: Continued use of dieldrin, butt and ground sprays, has reduced this pest to the status almost of a curiosity. This reduction has taken place over four seasons. The routine, annual application of dieldrin, could now be extended to a 2-3 years interval in beetle-free plantations because of the present low incidence of this pest.

Monolepta Beetle *(Monolepta australis)*: Adult beetles infesting different crops were recorded in the August, 1958, to February 1959, period. Repeated light swarmings occurred in August, 1958 on flowering avocados, macadamias and mangoes; and good control of settled swarms on avocados at Duranbah was obtained by fogging with DDT-oil mixtures.

Banana Rust Thrips *(Scirtothrips signipennis)*: Annual application of dieldrin sprays to the bases of plants and adjacent soil in spring suppresses rust thrips movement until about December. Unless follow-up applications are made, fruit damage usually occurs in January and subsequent months in plantations with a long record of rust thrips incidence.

Banana Red Spider *(Tetranychus lambi)*: Several acaricides were tested against red spider, and the value of "Kelthane", "Phenkaptone" and "Trithion" was demonstrated.

Livestock Pests:

Sheep Itch Mite *(Psorergates ovis)*: Several possible miticides for this work were screened. The following materials were tested and discarded: "chloro-benzilate, chlorpropylate, zineb, "Phenkaptone", "Kelthane", "Alodan", "Asuntol" and "Neguvon"; a mixture of ortho-dichloro-benzene and DDT also gave control, whilst diazinon used at twice the concentration normally recommended for blowfly control gave unsatisfactory initial kill of mites.

Elimination of mites from the experimental pairs of sheep was obtained with malathion, lime sulphur, "Dymite" (a commercial product containing the delta isomer of BHC) and some of the arsenical formulations.

Work is being conducted with glycerine-based arsenic-dieldrin, and arsenic-derris plus wetters. The value of a single and double dipping in sodium arsenite is also being checked.

Sheep Blowfly *(Lucilia cuprina):* Investigation of insecticidal resistance in the sheep blowfly was continued. Dieldrin-resistant flies are widely established throughout the State.

Because of the resistant strains and the need for an alternative insecticide, trials were undertaken in conjunction with private firms to ascertain the merit of diazinon when correctly applied. This work established that diazinon will give effective control of fly strike in sheep, provided the wool is saturated with insecticidal liquid at the time of treatment.

Laboratory studies with dieldrin-resistant strains of flies have established that the flies are also resistant to aldrin, BHC, endrin, isodrin and chlordane, but are not resistant to either DDT or diazinon.

A method has been developed to raise the order of dieldrin resistance to a very high level with one selection. Male flies able to withstand a level of insecticide toxic to all susceptible flies are first sought. The males are then mated with virgin female flies. Two to four days after mating the female flies are treated with a dieldrin dosage known to be toxic to heterozygote and susceptible flies. Provided there are any survivors the progeny of these female flies contain at least 50% resistant individuals.

Because sheep blowfly resistance to organic phosphate insecticides might develop, a selection programme has been commenced, with diazinon and malathion, on both susceptible and resistant strains of flies. This programme is now in its fifth generation, but there is no evidence of physiological resistance, although vigour tolerance is suspected. An interesting aspect of this study is the indication that dieldrin-resistant flies are slightly more susceptible to diazinon than susceptible flies.

Preliminary genetical studies on dieldrin-resistant strains indicate that resistance may be explained in terms of an oligogene. This tentative conclusion is being checked, due to reversion being noted in the resistant strain of flies used in the crosses.

The original resistant strain of flies, held in the laboratory for nineteen months, has passed through twenty-five generations, and is now fully susceptible again. There is evidence that susceptible individuals begin to appear after some ten generations, but as already indicated a high level of resistance can be developed again with a single selection.

Tick Control Research

DDT-Diazinon Dip: Observations on effect: The one DDT diazinon dip in the area has been maintained for a further twelve months. On field observations, the dip at a strength of 0.5% DDT and 0.05% diazinon has been entirely satisfactory for control of cattle tick infestation.

Diazinon and DDT Deposits on Hair of Dipped Cattle: Some work was undertaken in association with the firm which supplied the diazinon.

The results indicated:- (1) that the amount and distribution of diazinon deposit on the hair varied from animal to animal, the belly retaining the most, and the mid-rib the least; (2) that DDT deposition followed a definite pattern; the top line retaining the most, and the mid-rib the least; (3) variation in DDT deposits was not constant with either the length of hair or the diazinon deposition; (4) only 19% of the initial diazinon deposit remained after four days, and after seven days it had almost entirely disappeared - the lack of retention in these trials was attributed to the prevailing high temperatures and the short coats of the animals.

Stored Products Pests

Grain Weevils *(Calandra spp.)*: A small trial confirmed the effectiveness of 3% malathion in wettable powder and emulsion forms as a residual spray in and around silos prior to filling with grain. A long term storage trial with wheat is in progress at Temora Experiment Farm, using magnesite. Considerable interest is being shown by farmers in this method of grain protection.

Fly Control:

A large-scale, fly abatement campaign by use of aircraft was observed at Bathurst where an attempt was made to eliminate the fly population from around a large cannery. The campaign was not successful and the fly population was only temporarily depressed. A "Micron" concentrate sprayer was tested to determine the practicability of its use in the application of residual sprays to the large fly infested areas of the city. It was considered to provide more efficient application than was obtained from aircraft.

Argentine Ant

The Argentine Ant Eradication Campaign: The Argentine Ant *(Iridomyrmex humilis)* Eradication Campaign in the Sydney district is now in its 6th year of operation, and a total of some 3,600 acres of infestation is known.

Cost of the campaign to date is approximately £84,500, half contributed by the New South Wales Treasury and other half by local government bodies in whose areas the eradication work is carried out. As the end of this large scale eradication experiment is in sight, plans for continuation of the work as a service project are being considered - to ensure final eradication of all known infestations and others likely to be reported.

Toxicological Research:

BHC and DDT Calf Dipping Trials: Effect of dipping calves in a wash containing BHC and DDT of known concentration was further studied. Thirteen calves of mixed breeds, and ages ranging from seven to eighteen weeks were used in the trial. All were maintained in good condition throughout the trial by supplementary feeding, and worm free by regular faecal examination and treatment as required. Weight gains were recorded over the period.

The wash was maintained at 0.5% p.p.i. DDT and 0.03% gamma BHC throughout, and the calves were exercised for one mile at a brisk trot before and after dipping.

At no stage were typical symptoms of BHC toxicity produced. At the end, all but the youngest (which died during the trial) were in very good condition. They had gained considerable weight.

(New South Wales, Department of Agriculture, Annual Report for 1959.)

Veterinary

Persistence of DDT on Cattle Hair: Previous investigations have shown a marked difference in persistence of DDT on the hair of cattle stalled indoors compared with that of grazing cattle. This could be due to a number of factors, including weathering, sunlight, coat characteristics, and coat licking. These factors were evaluated on Hereford steers during midsummer. Twelve animals were paired with respect to coat characteristics. The right side of the barrel was scrubbed on all animals and anti-licking harness was attached to three animals in each of the indoor and outdoor groups. In both groups, animals fitted with anti-licking harness were maintained separately. Following dipping, hair samples were taken daily for 21 days from three 2 in. squares on each side of each animal. These squares were taken according to a statistically randomized pattern and were bulked for analyses. In this investigation coat licking was the major factor affecting the persistence of DDT on cattle hair.

Sheep Blowfly Control: "Bayer 1090" when used at a concentration of 0.1% active principle was not effective when checked three weeks after jetting.

"Bayer 1752" gave slightly better results. At a jetting concentration of 0.1% it was effective for 4-5 weeks; when jetted at 0.05% it was effective for about 4 weeks.

"Bayer 1751" at 0.95% was still effective 11 weeks after treatment.

"Nankor" (Dow Chemical Co.,) also known as "Korlan", was effective for 14 weeks when jetted at a concentration of 0.1% and 20 weeks at a level of 0.2%.

Diazinon used at a level of 0.02% was the reference insecticide, and in these trials was effective for 11 weeks.

(Queensland Dept. of Agric. and Stock, 1959-60 Ann. Rep.)

Sugar cane

Grub Control Experiment: In laboratory tests 99.9 per cent lindane, a 50% micronized lindane wettable powder, and 20% crude BHC dust mixed with soil in concentrations of 4,8, and 16 parts of active ingredient per million, were equally effective against cane grubs both in speed of action and final mortality. These tests were completed under laboratory conditions within a few weeks of the insecticides being mixed with the soil. One aspect that was not resolved was whether the different particle sizes, or the extraction of the lindane from the inactive isomers, will affect the persistence of lindane in the soil, an important aspect of the economy of grub control in Queensland where a single dressing gives three years of protection. Field trials with lindane and crude BHC dust designed to supply that information have not suffered sufficient grub infestation to give results. To obviate that impediment to progress, concrete enclosures are being constructed in which insecticides mixed with soil can be exposed to the elements and the effects of cane growth, and the residual efficacy of the insecticide determined by bio-assay at suitable intervals of time. In pot tests 20% crude BHC dust, 50% micronized lindane wettable powder, aldrin, dieldrin, and heptachlor were screened at 4,8, and 16 parts of active ingredient per million of air-dry soil, against greyback grubs. During the first week lindane and crude BHC acted more rapidly than the other insecticides, but complete mortality of grubs was obtained in all the insecticides at all concentrations in four weeks. In a similar test against Childers grubs, mortality progressed more slowly and was not complete with the lowest concentration of lindane until the tenth week, at which time there was still 15% survival in the lowest concentration of crude BHC. However the progressive comparisons between lindane and crude BHC in the interim period did not justify a deduction that crude BHC was in practice less effective than lindane. Aldrin, dieldrin, and heptachlor caused only slight mortality of Childers grubs as also did "Sevin" and "Trithion" which were used at only 16 p.p.m.

In two field trials with BHC against "Mossman" grubs at Rocky Point in which negligible infestations were encountered in 1959, the average number of grubs found per stool in untreated control plots in 1960, was 7.0 in one trial and 7.2 in the other. However, for reasons which are not known these grubs did not cause any detectable symptoms of damage, and in one trial which was harvested, the yields from untreated and variously treated plots showed no significant difference. Quantitative BHC field trials against frenchi and consobrina grubs, which included a comparison between sprayed lindane and crude BHC dust, have not been sufficiently infested since their inception in 1958 to yield useful information. In a BHC trial against the Childers grub, in which 20% BHC was applied at rates of 150,300 and 600 lb. per acre, broadcast before planting, these rates being either divided equally between an application ploughed in deeply and a second application disced in, or fully applied and ploughed in, results in the plant crop indicated that a minimum requirement for control was the deep ploughing in of not less than 150 lb. per acre, and still larger amounts might be required for complete control. This trial did not include any applications in the drill. The sporadic and uncertain occurrence of the Childers grub renders chemical control at such heavy rates a doubtful economic proposition, which even the lower priced lindane might not fully alleviate, and it could well be that the long-standing recommendation to destroy the larvae by suitable cultural practices before planting, may, together with the use of resistant varieties, remain the most practicable approach to the problem for some time to come.

In the long range investigation into whether BHC, crude or refined at the rates generally used for grub control, may eventually affect soil fertility, the harvesting of a first ratoon crop at Babinda, and a second ratoon crop at Bundaberg supported the evidence of previous cropping cycles that no change in fertility has taken place.

With a view to setting out field trials against termites, particularly the giant termite, *Mastotermes darwiniensis* Frogg., which destroy germinating setts, and to exclude which a complete protective envelopment of the sett might be necessary, a preliminary phytotoxicity trial was set out in which lindane, aldrin and heptachlor as wettable powders were added at 0.25% concentration to a mercurial sett dip. As an alternative, or in addition, to the dip, lindane and aldrin were applied in the furrow at half-a-pound and at one pound per acre, and heptachlor at one pound per acre, the applications being divided into a three to four-inch wide band in the bottom of the furrow before the setts were laid, and a second band of similar width over the laid setts and adjacent soil. Aldrin and heptachlor had no important adverse effect on germination either as a soil spray or a dip or when both were combined, nor did lindane with respect to the soil spray, but the latter did cause erratic, adverse effects when used as a dip alone or with soil spray. The lowest mean germination obtained, where the lindane dip was oombined with the one pound soil application, was 73% of that obtained from controls dipped in mercurial only.

Funnel Ant, Aphaenogaster pythia Forel:

In exploratory plots at Tully in 1958 aldrin at 20 lb per acre, broadcast and ploughed in, completely prevented ant infestation in the plant and first ratoon crops; first ratoon cane on the treated plots is now distinctly superior to adjacent unprotected cane. Since the 20 lb. application also inhibited infestation for some distance downhill outside the treated plots, lower rates were used in a randomised trial set down at Meerawa in 1959. Aldrin at 5,10, and 15 lb per acre was applied by three methods viz.

(1) entirely broadcast and ploughed in prior to planting.

(2) divided equally into two broadcast applications one before and one after ploughing, the latter being subsequently disced in.

(3) entirely applied as a side dressing in the half-open drill five months after planting.

In the plant crop untreated plots became heavily infested. Infestation was established before the half-open drill application was made; nevertheless that treatment effected a marked reduction in the number of craters to be found. The single ploughed-in application completely prevented infestation where 10 or 15 lb. was applied, but permitted minor infestation in the 5 lb. rate. The divided broadcast application was slightly less efficaceous, minor infestation occurring at all rates.

Soldier Fly, Metaponia rubriceps Macquart:

In a trial at Bundaberg in which gamma BHC at 2,4 and 8 lb., aldrin at 4 lb., and dieldrin at 2.4 lb., per acre were broadcast and grubbed in late May, 1958, and left undisturbed for four weeks before the field was planted. Normal first ratoons were obtained where 4 or 8 lb. of gamma BHC had been applied, and no larvae were found in the soil, whereas the other treatments, and untreated controls, resulted in poor ratoons; two stools in untreated plots yielded 48 and 21 larvae and 51 were obtained under a stool in the aldrin treated area. Similar dressings of BHC have failed to give any control where they were applied in July, August or September or where an application made in April was distributed within one week by planting operations.

Earth Pearls (Margarodidae)

Life history studies are being continued with earth pearls. Although *Eumargarodes laingi* Jakubski has a one-year life cycle, individuals of another un-named species associated with sugar cane, may reach the adult stage in one year, while others require two or even more years to reach maturity. Cysts of the un-named species which were collected in 1956 and kept in glass tubes without soil nutriment until 1959, resumed feeding and growth when placed close to cane roots. While the cysts lack mobility, if a root being used for food died the feeding tube could be transferred, it was found, to a new root growing in the vicinity. Some cysts maintained their tubes in roots continuously, while others withdrew the tube intermittently for periods of at least several days. No correlation was detected between apparent feeding and growth. Only about half the cysts observed to feed increased in size, the increase in size being accomplished by a fracture of the cyst at the pole farthest from the feeding tube; whether that fracture coincides with a change of instar remains to be clarified. In a field trial at Qunaba, Bundaberg, in which aldrin and BHC had been applied to the soil, there was no apparent benefit from the use of either insecticide.

(60th Annual Report of the Bureau of Sugar Experiment Stations, Brisbane, Queensland, 1960.)

AUSTRALIA - WESTERN

Rice

Stem-borers: Stem boring caterpillars have severely damaged rice crops at the Kimberley Research Station, near Wyndham, and studies have been made on the biology, abundance, and control of these insects.

The insecticides, DDT and BHC, were applied as dusts previous to 1957. These dustings though effective in killing many moths, did not serve to prevent further infestation.

During the last few years, endrin dust has been repeatedly used at the rate of 2 oz. a.i. per acre. The moth population has decreased during this period but other factors, such as climate or biological control, may also have been responsible for this reduction in moth numbers.

(The Journal of the Department of Agriculture, Western Australia, Dec. 1950 Vol. 1, No.12.)

CANADA

Spruce budworm: A one year agreement was concluded whereby the Federal Government would contribute up to a maximum of $550,000, one-third of the cost of an aerial spraying operation to be carried out in 1960 against the spruce budworm, on an area of approximately 2¼ million acres. The Government of New Brunswick and the forest industries in the area affected will each contribute one-third of the cost. Spraying operations will be carried out by a Crown corporation, Forest Protection Limited, organized for that purpose.

(Dept. of Northern Affairs and National Resources, Annual Report, Fiscal year 1959-1960.)

CANADA - NEW BRUNSWICK

Spruce Budworm: Preparations are being made for a resumption of the aerial spraying operations in 1960. In the interests of preventing damage to young salmon the strength of the insecticide being used is being reduced to one half of a pound of DDT to the U.S. gallon of insecticide, on the area being sprayed in the Miramichi watershed. This will result in an average dosage of one quarter of a pound of DDT per acre. This change is being made on the recommendation of the Federal Interdepartmental Committee on Aerial Spraying and is based on the results of experiments carried out by the federal authorities with the cooperation and assistance of Forest Protection Limited.

(123rd Annual Report of the Department of Lands and Mines of the Province of New Brunswick, for the year ended 31st March, 1960).

INDIA

Agricultural Pest Research

Maize Stem Borer: Two sprayings with different insecticides were given against *Chilo zonellus* Swin. and the third spraying was given against aphids. The concentrations of different insecticides used were: 0.1% DDT, 0.1% BHC, 0.05% endrin and 0.05% systox. During the second spraying concentration of endrin was increased to 0.1%. The statistical analysis on the reduction of *Chilo* larvae and pupae population after each spraying showed that treatment with BHC in the 1st and 2nd spraying was significant and the percentage reduction was 82.8 and 94.1 respectively. DDT treatment indicated significant reduction in the population in the 1st spraying only. Endrin in the 1st spraying brought about 71.4% reduction but this figure was not found to be statistically significant. Analysis of the percentage reduction in damaged plants after each spraying showed that BHC treatment was significant in reducing the damaged plants in the 1st and 2nd sprayings and treatment with endrin showed significant reduction in the 1st spraying only. Analysis of the yield of maize grain did not show significant differences between the insecticides and the control.

Cotton Pests: The spraying of cotton crop with endrin at the rate of ½ to 1½ lb./acre was carried out. Observations after the fifth spraying showed that the population of jassids, thrips, white-flies, mites, aphids and spotted bollworms was reduced by 65%, 91%, 98%, 39% and 99% and 94% respectively whereas that of pink bollworm increased by 19%.

Mustard Aphid: Experiments on the control schedule for mustard crop showed that the highest degree of aphid control was achieved in the plots treated with parathion, followed by DDT/BHC mixture, gamma BHC, diazinon, malathion, nicotine sulphate.

Use of Fumigants: Fumigation of the rust and flourbeetle in an empty space showed that carbon disulphide was most effective followed by EDCT mixture and carbon tetrachloride. In the presence of commodities, on the other hand, the relative efficacy was in the following order: carbon disulphide, carbon tetrachloride, ethylene dichloride, carbon tetrachloride mixture, and ethylene dichloride. Carbon tetrachloride gave an almost complete kill of the important storage pests except Khapra grubs when used either at 10 lb./1,000 cu. ft. for 24 hrs. or at 7½ lb/1,000 cu. ft. for 48 hrs. Carbon disulphide could kill all the stages of bruchids when used at 20 mg./l. for 24 hrs. Larvae of rice moth were found to sorb the largest amount of hydrocyanic acid gas, followed by bruchid adults, Khapra larvae and rice weevil. The relative toxicity of different fumigants to the mango mealy bug was in the following order: hydrocyanic acid gas, methyl bromide, "Acrylon" carbon disulphide + ethylene dibromide, carbon disulphide, and carbon disulphide + carbon tetrachloride.

(Scientific Report of the Indian Agricultural Institute, for the year ending 30th June, 1958.)

Cotton Pest Control:

Punjab: Spraying trials involving chemical control of insect pests of cotton crop initiated during 1957-58 and repeated at Ludhiana and Patiala during 1958-59 confirmed the previous finding that spraying the cotton crop either with a combination of DDT 0.1% and BHC 0.1% suspensions or endrin 0.02% emulsion caused complete mortality of whitefly and jassid within 72 hours after spraying and kept the pest population under check for one week after which the pests began to develop again. In addition to controlling cotton jassid and whitefly, these cover sprays reduced the incidence of spotted and pink bollworms in the treated crop to 20% of that in the control plot.

Out of the three spraying schedules of 7/21 days, 10 days and 14 days intervals tried during the year, the schedule with an interval of 7/21 days did not prove very effective because a gap of 21 days between the sprayings allowed the pests to multiply in large numbers. There was very little difference between the other two schedules so far as cotton yield was concerned though pest population remained slightly at a lower level with the schedule of 10 days interval as compared to that of 14 days interval.

Phosphatic insecticides such as parathion, diazinon, malathion, and thiometon tested in these trials, though quite effective so far as initial kill was concerned, were found to possess poor residual effect.

Observations regarding the carry-over of the pink bollworm infestation from year to year revealed that the bolls left unpicked on the cotton sticks stacked for burning purposes offered the greatest protection to pink boll worm larvae harboured in them and as such played an important role in the carry-over of the pest from year to year. Over 8% of these bolls were found to harbour live pink bollworm larvae up to the middle of June. These larvae were found to pupate successfully in the last week of June from which adults emerged in the first week of July when next cotton crop was available in the fields.

Fumigation trials with ethylene dibromide showed that it acted as a spot fumigant with a slow rate of downward penetration. With a dose of 3 lb. per 1000 cubic feet and an exposure of 96 hours it caused 100% mortality of the pink bollworm larvae up to a depth of only 3 ft. 4 in. beyond which the mortality was only partial. The cost of fumigation worked to Rs. 8.70 nP.[†] for 1000 cubic feet of space or 3.5 nP. per maund[‡] of cotton seed fumigated.

Bombay: Trials at Surat indicated that spraying endrin at 5,6 and 7 oz. per acre resulted in significantly higher yields in the case of 170-Co.2 although no significant decline in the percentage of incidence of bollworm in bolls and locules was observed. In the case of 2087, however, spraying with endrin 5,6 and 7 oz. proved to be effective in reducing the incidence of the pest, while significant increase in yield was observed only in treatments with 5 oz. of endrin per acre and 0.2% "Gusathion."

Spraying of Virnar with endrin at 4 oz. per acre at intervals of 10 days at Dhulia and 8 oz. per acre 6 to 7 times on 170-Co.2 at Baramati resulted in the highest yield of *Kapas* besides reducing the incidence of the bollworm.

As regards dusting experiments, 1% and 0.5% endrin at Surat and 1% endrin at Dhulia and Baramati reduced the incidence of bollworm both in the bolls and locules besides giving significantly higher yield.

In general, the treatments with endrin were found to be more effective in controlling the pest and increasing the yield than those with other insecticides.

Mysore: During the year under report, three experiments were conducted, the insecticides used being "Basudin", endrin, "Folidol", BHC, "Geigy 1250" and malathion. In all the three experiments the insecticidal application was started 45 days after sowing, the interval between successive treatments being one month in the case of experiment I, 10 days in the case of experiment II and 15 days in the case of the third experiment. The observations were confined to the incidence of jassids, aphids, thrips and bollworms.

The results of all the three experiments indicated endrin to be the most effective of the insecticides tested, followed by "Folidol", "Basudin" and BHC.

The residual effect also appeared to last longer in the case of endrin. Significant increase in yield was recorded in many of the treated plots the most consistent being the plots treated with endrin, where the increase was of the order of about 300% in experiment II.

Andhra Pradesh: The insecticidal trial for the control of pink and spotted bollworms was conducted on Northerns 14, in randomised and replicated plots. Endrin and parathion were sprayed in three concentrations with appropriate controls. The first spraying was done in the month of January, 1959, when the infestation of bollworm was observed and the second was given after a fortnight i.e., in the second week of February. A comparison of the controlled plots with the treated plots, indicated that while in the former the infestation recorded was 21%, the treated plots showed only 5 to 9% infestation. Owing to the commencement of bursting of bolls subsequently, the third spraying was not done. At the time of harvest during April, the infestation in the control had increased from 21% to 68% while in the treated plots it had gone up to 66%, except in the plots treated with endrin 0.043%, when it had increased to 54% only. Taking the overall picture of all the plots, it was found that the reduction of incidence due to treatments ranged only from 2 to 14%, indicating that incidence went on increasing even in the last of the crop growth after the second spraying. It is, therefore, concluded that the spraying schedule would have to be continued till the end of March commencing from December.

[†] nP = neye Paise (100 nPs = 1 Rupee).

[‡] 1 maund = 82 2/7 lbs. cotton.

It was also observed that higher concentrations of the insecticidal treatment reduced the pest attack. Thus, the plots sprayed with endrin 0.43% showed the lowest infestation, compared with 0.021% concentration.

The analysis of yields obtained also indicated that plots treated with endrin gave higher yields than those treated with parathion.

In working out the economics of spraying, it was found that the cost for spraying the crop twice with endrin 0.043% amounted to Rs. 18.66. The cost of parathion for spraying at 0.025% worked out to Rs. 12.40 per acre.

As regards control of jassids, it was found that spraying with DDT, endrin, parathion and diazinon gave 100% mortality after 48 hours. These sprayings were completed before the crop attained about two and a half month's growth and the crop was in the field after the spraying for five months. It was also observed that a few jassids which appeared later, did not produce any visible effect on the crop. On account of the general low incidence of jassids, however, the yield differences between the treated and untreated plots were not significant during the year.

(Indian Central Cotton Committee, Thirty-eight Annual Report, 1959.)

Timber Borers:

Tests, to protect timber and bamboo in storage from borer attack are being carried out with the following materials:

DDT 5% and 10% in kerosene oil; 'Bosan C' (Geigy's), a DDT. product with fungicides; BHC. 0.5% and 1% in kerosene oil; copper napthenate 5% in kerosene oil; "Celcure"; zinc chloride, copper sulphate and sodium fluoride, each with BHC.; chromated zinc chloride (C.Z.C.); common salt in saturated water solution; borax 0.5% and 1% in water solution; indigenous insecticides, namely, cashewnut shell extract, *Adina cordifolia* leaf extract in alcohol, and *Strychnos nux-vomica* fruits in alcholic extracts; and creosote.

Various experiments were laid out in the Jhajra Forest near Dehra dun, using billets of *Bombax malabaricum* and *Terminalia belerica*. So far it has been found that DDT. and BHC., especially the latter, are effective against the pin-hole borers and the ambrosia beetles (Scolytidae and Platyodidae) during the rains, and against the powder-post beetles. The other insecticides were either much less effective or valueless.

Termites

Observations were continuing on experiments reported last year. The BHC treated resin-bonded wood waste boards, exposed last year, are free; untreated boards (controls) show slight grazing by termites.

Wood Preservation

In view of the non-availability of arsenic pentoxide in the country, the inventor of ASCU has recently taken out a patent substituting boric acid in place of arsenic pentoxide in ASCU. The leaching and toxic properties of this preservative have been studied. It appears to be satisfactorily fixed in timber - leaching being less than one per cent. The results so far obtained on accelerated durability tests on thin veneer after a period of two years show that all the treated specimens are sound; the untreated ones were all destroyed within 6-9 months. The preservative resembles "Celcure" - another preservative which has given satisfactory results under Indian conditions.- except that in place of acetic acid, boric acid has been used here. Since boric acid is toxic to *Lyctus* type of insects this preservative should prove more useful than 'Celcure'. With the results so far obtained the copper-chrome-boric composition can be recommended for treatment of timbers for indoor use and for treatment of packing cases. Field tests on its performance for outdoor use are being taken up.

The inorganic preservatives, especially of the fixed type containing dichromate, get precipitated when heated in contact with timbers which contain many reducing substances. This, therefore, becomes a handicap when such preservatives are used for treating timber by the hot and cold process. Systematic work on the sludge formation with various inorganic preservatives was undertaken with a view to studying the factors contributing to sludge formation and eventually to controlling the same.

Experiments were conducted in the laboratory and in the field on the 'prophylactic' treatment of timber and bamboo especially in the green state with a view to protecting them from deterioration due to fungi and insects (white ants and borers) during warm, wet monsoon months.)

Treatment schedules for laurel *(Terminalia tomentosa)* and *chilauni (Schima wallichii)* using pentachlorophenol in a suitable medium (mineral oil) were worked out. B.G. sleepers from both the above species were then treated with the preservative for service tests on the railway track. For purposes of comparison a similar number was treated with creosote-fuel oil (50:50) mixture.

On behalf of the Technical Development Establishment, Kirkee, experiments were undertaken on low pressure treatment of timbers used for packing cases. For this purpose about 1" thick planks of *Albizzia lucida*, *Boswellia serrata*, *Artocarpus hirsuta*, *Michelia champaca*, *Dalbergia sissoo* and *Pterocarpus dalbergiodes* (containing sapwood) were treated using pressures of the order of 25 lb. to 59 lb. per sq. in. for 1½ hour. The penetration of the preservative has been found satisfactory, especially in the sapwood. A suitable treating plant employing these low pressures for the preservative treatment of timbers for packing cases, ceiling and door and window panelling was designed. It is estimated to cost about Rs. 5,000 and can be manufactured in India.

(Forest Research in India, 1951-52, Part 1 - The Forest Research Institute. Published at Delhi 1959.)

NEW ZEALAND

Wallaby Eradication: Wallabies are spread over about a million acres, the main concentration being in about 250,000 acres in and around the Hunter Hills. Infestation ranges from odd, scattered animals to more than one wallaby per acre.

Action was taken after representations had been made to the Government of the danger of the spread of wallabies and of their becoming a national problem. The Rabbits Act was amended in 1959 to allow Rabbit Boards to accept responsibility for destroying wallabies, and a Rabbit Boards Wallaby Destruction Committee formed.

Following preliminary trials, extensive aerial operations were started last year. The bait mixture in use consists of:-

Pollard - 32 lb.
Molasses - 25 "
Linseed - 56 "
Flour - 16 "
Sugar - 16 "

Oil of aniseed - 8 oz.
Stock solution of 1080 - *19 oz.

Water 1 gallon
Oil of raspberry 8 oz.

* Stock solution of 1080 = 1 lb of powder in ½ gallon of water.

This poison was applied successfully from the air first over 14,000 acres in the Upper Pareora district, then over 15,700 acres in the Waihaorunga district. Over 80,000 acres have been treated during an eight month period. It is estimated that in that area with more than one wallaby to the acre a 95% kill has been achieved.

(New Zealand Journal of Agriculture, Jan. 1961 Vol. 102 No. 1.)

White-Fringed Weevil (Graphognathus leucoloma): For the present the following control measures have been recommended:

Spraying nursery beds with dieldrin 15% e.c. at a rate of 1½ pints in 40 gallons of water per acre in the months of October, December, February, and April for the control of larvae, and ½ pint per 40 gallons of water for the adults. The low dosage at frequent intervals has been recommended due to reinfestation from outside the nursery and to the sandy type of soil.

Selidosema suavis: Control experiments have been proposed.

(Report of Forest Research Institute, for the period 1st April 1958 to 31st Dec. 1959. New Zealand Forest Service.)

WEST AFRICA (GAMBIA, GHANA, NIGERIA, SIERRA LEONE)

Loiasis research: Chrysops control:

Studies on insecticides. The final analyses of samples of mud, collected at intervals from natural breeding-sites treated with emulsions of DDT, dieldrin aldrin, and BHC, and with dieldrin granules, have now been received from the Colonial Pesticides Research Unit at Arusha, Tanganyika. They confirm the previous finding that dieldrin is the most potent and economical insecticide for use against *Chrysops* larvae.

Field trials were then undertaken to determine the minimum concentration of dieldrin effective against *Chrysops* larvae. Emulsions containing 1.25%, 0.625%, 0.3125% and 0.15625% of dieldrin were applied to selected sites at a rate of four pints to 100 sq. ft. of mud. The sites were examined at monthly intervals to discover when *Chrysops* larvae re-appeared in the treated areas. Up to 10 months after spraying, all the sites were free from larvae.

On the basis of the laboratory tests described in earlier Reports and of the various field trials it was considered that sufficient information on the value of dieldrin against *Chrysops* larvae had been obtained, and it was decided to initiate a pilot control scheme by spraying all the breeding-sites within a three-mile radius of Kumba Government Station. It was found convenient to apply an emulsion containing 0.676% of dieldrin at a rate of 50 gal. per acre of breeding-site, using 'Motoblo' sprayers. In many of the larger breeding sites traces have had to be cut to facilitate application of the insecticide.

Circumstances beyond the Unit's control gave rise to unforeseen delays in obtaining supplies of the insecticide with the consequence that spraying did not commence until the rains had started. In addition the breeding sites were found to be more extensive than the earlier surveys had indicated, and progress is therefore slower than had been hoped. It is unlikely that the spraying programme will be completed before the end of the rainy season.

(West African Council for Medical Research, Annual Report 1959-60.)

GHANA

Cocoa

Joint WACRI/Division of Agriculture Capsid Control Trials: The series of trials in Ashanti begun in 1958, to compare the effectiveness against capsids of endrin applied at ½ oz per acre, gamma-BHC at 1 oz and aldrin at 2 oz, that is at rates approximately proportional to their cost (see Quarterly Report; W.Afr.Cocoa Res.Inst.No.50), have now been concluded. Sufficient data have been collected to show that endrin at the ½ oz rate is significantly superior to 1 oz of gamma-BHC, but the difference between gamma-BHC and 2 oz aldrin is not significant. It is hoped to publish the results of these trials more fully elsewhere.

Joint WACRI/Division of Agriculture: Ant/Mealybug Control Trials: - Method of Application and Formulation Trials: These joint WACRI/Division of Agriculture trials which were commenced in July, 1959 with first dieldrin application in September (Quarterly Report No. 54) are giving interesting preliminary results. All treatments have reduced ant population to less than 25% of the pre-treatment figure. This has resulted in a corresponding but greater fall in the mealybug population.

Observation has been made on the plots on the incidence of *Eulophonotus myrmeleon* Feld., *Tragocephala* spp. and another borer which has recently made its appearance following the use of dieldrin, identified as belonging to the family Metarbelidae. From pre-treatment assessment of no damage, *Eulophonotus* attack has developed on all the treated plots but none have been found on the control plots. As yet no other species of borers have been found.

Pilot Experiments with Tagged Rogor 40: A preliminary experiment to follow the uptake and translocation of Rogor 40 by cocoa has been carried out. Mature leaves of fans and chupons were painted with tagged material and assessment was made after 24 hours, 3 days, 7 days and 14 days. Five fan branches and five chupons were used for each assessment period.

Further trials with soil, leaf and bark application to seedlings have also been started.

Persistence of Insecticides: Harvests of 150 leaves from each plot were carried out after 24 hours, 3 days, 7 days and 14 days, following spraying with 1 oz and 2 oz endrin, 2 oz and 4 oz aldrin and 2 oz and 4 oz "Gammalin 20", at 5 gallons/acre, (Quarterly Report No. 56). Application was also made to the same plots after 24 days to obtain a single sample of each treatment one hour after application.

Extraction of surface residues was made by washing in 62/82°C petroleum ether. The concentrate was evaporated off inside small glass vials and estimates of insecticide residue made by bio-assay using *Drosophila melanogaster* (Woodstock laboratory strain). Direct bio-assay with harvested leaves was made by caging capsids, *Distantiella theobroma*, with leaves in lamp glasses.

The results of this preliminary trial have not been finalised as yet but will be reported with the results of the chemical analysis being carried out on endrin and aldrin residues.

Shot Hole Borer Studies

Alakia I: Previous experience has indicated the inadequacy of normal insecticidal techniques in the control of shot hole borer *(Xyleborus morstatti* Hag.) of cocoa. (Quarterly Reports 52 & 53). An experiment laid down at Alakia I., to study the effects of four cultural treatments on virus and non-virus infected seedlings, also provided an opportunity to investigate the incidence of shot hole borer under a variety of conditions. At the time that shot hole borer counts were made (January, February and March, 1960) virus had not been introduced into the plants.

Statistical analysis of the data collected at the end of January indicated that significantly less ($P = .005$) plants were attacked in the bare soil and mulched plots (C & D) than in those with a growing cover (A & B). The borer counts were in February and March more similar to those of January. At no time did a difference in susceptibility to attack emerge between Amazon and Amelonado plants.

Koroboto II: Counts were made on this plot (planted in June, 1958) in January, 1959, to observe the effects of several factors (shade and no shade, severe virus, mild virus and no virus, *Calonectria* and no *Calonectria)* and their interactions, on shot hole borer incidence. Whilst no clear correlations emerged between borer incidence and any of the treatments, the percentage of plants attacked was quite high (32.2).

Counts made just a year later, in February, 1960, whilst still showing no correlation with any of the factors imposed on the plants, were much lower (4.5%) than in the previous year. This tends to bear out the idea that, except in the most marginal of cocoa growing areas, shot hole borer is only a major pest in the first year after planting. This is quite unlike the position with coffee, where *X.morstatti* causes continual trouble throughout the life of the tree, though generally on first and second year wood only.

(West African Cocoa Research Institute. Quarterly Progress Report No. 57, Jan.-March 1960.)

NIGERIA (Western Region)

Public Health:

Malaria: Malaria remains indisputably the chief insect-borne disease. Control continues by old and routine measures directed against mosquito larvae together with residual spraying in certain areas. The Entomologist visited as many areas as possible and conferred with health staff to find out what the position was as far as mosquito control was concerned. It was evident, as has been obvious for years, that the biggest and only real draw back to efficient mosquito control is lack of money. This leads to a lack of equipment, lack of insecticides and larvicides, and a lack of labour.

Onchocerciasis: The distribution of Simulium, particularly that of *Simulium damnosum* Theobold, is to be ascertained by simple surveys in the near future. Already it has been shown that *Simulium damnosum* is present in Oka (Ondo Province), Ibadan, Oke-Iho and Oyo.

Plague: During the year no cases were reported, and in the few rats that were dissected in none was there any evidence of this disease.

Yellow Fever: No cases were reported from the Region during the year. Where *Aedes* indices were reported to be above the safety level, prompt measures were instituted.

Schistosomiasis: In Epe Division and in certain areas of Egbado Division particularly, this disease is a major problem.

Trypanosomiasis: The region still enjoys freedom from human trypanosomiasis, but the Veterinary Department continue to find the condition in cattle.

(Annual Report of the Department of Medical Services, Western Region of Nigeria, 1st Jan., 1957 - 31st Dec., 1957.)

Forest Pest Control:

In the Ogba Fuel Plantation, Benin, it has been found that *Pentaclethra* seed is only attractive to rats at the time when the shoot first emerges from the cotyledons. Experiments in pre-germinating the seed in drums of moist sand are proceeding.

In Omo Reserve, the Provincial Forest Officer reports damage to lime planted saplings by elephant. He also reports attack by an unidentified grub on live Opepe in Akilla plantation. Investigation is proceeding and inecticide sprays will be tried.

Attack by powder post beetles in sawmill yards especially on sapwood has been reported by one Company. Spraying with insecticide immediately after sawing has controlled the damage.

It is now normal practice for the Posts and Telegraphs Department to spray Opepe telegraph poles at stump as soon as they are de-barked. This is essential because of the speed with which ambrosia beetles attack the poles after felling.

There is an increasing awareness among timber firms of the necessity for spraying both logs and sawn timber, which has been a common practice with the more progressive firms for some years. It is hoped that the next stage of introducing kiln drying and impregnation of non-durable timber with preservatives will follow the example set by the Railway Corporation and Posts and Telegraphs Departments' impregnation plants.

(Annual Report on the Forest Administration of the Western Region of Nigeria for the year 1958-59.)

Timber Preservation:

A timber impregnation plant, using both "Tanalith" and creosote was installed at Ibadan by the Posts and Telegraphs Department especially to treat the telegraph poles supplied from Forestry plantation thinnings.

(Annual Report on the Forest Administration of the Western Region of Nigeria for the year 1958-59.)

Forest Pests: No progress has been made with the solution of the problem of die back of Yemane *(Gmelina arborea)*. It dies mainly in the rainy season when 15-20 years old and the cause may be physiological. One tree that started to die in October recovered and sent up basal shoots in the dry season from November onwards but the top died. Every effort is being made to keep the plantations vigorous by early thinning.

Squirrels dug up Yemane seed sown at a wide spacing in transplant beds in the nursery at Bo. Monkeys continue to damage Bundui *(Nauclea diderrichii)* plantations by splitting the leading shoot open to eat the pith.

Hypsipyla grandella has not recognised Cedrela as a member of the Mahogany family with the result that striplings have been successfully planted.

(Annual Report on the Forest Administration of Sierra Leone 1958/1959.)

ADEN

Malaria: During the year 997 cases of malaria were reported with 14 deaths. With the exception of two of these cases it is not thought that the disease was contracted in the Colony, due to the absence of the insect vector. However, there is little doubt that two of the patients contracted the disease whilst visiting the township of Sheikh Othman and an extensive search of that township failed to reveal anopheline breeding. It is thought that the infected mosquitoes probably came from the village of Daar es Saad which is contiguous with Sheikh Othman and where the breeding is known. Mosquito breeding in Aden is almost invariably domestic as there is no standing water and the greatest vigilance is exercised over tanks, wells, pits etc., and during the year some 960,895 inspections were carried out.

Rodent disinfestation: The department continues to undertake rodent control on ships and harbour installations. During the year 184 ships were inspected for this purpose and 88 certificates were issued. An unusual request this year was for the de-ratting of an aircraft. The pilot had himself seen a rat on board. The danger here was not strictly a medical one. In view of the fact that a rat will gnaw through insulated cables, as a safety measure it was important to take the aircraft out of commission until it had been successfully de-ratted. A large rat was recovered after using sodium fluoro-acetate.

(Medical and Health Report 1958.)

BERMUDA

Spittlebug: Excellent control of nymphal and adult stages of the spittlebug, *Clastoptera undulata* Uhler, was achieved with both malathion and dieldrin. The effect of these materials on the eggs of *Clastoptera* has yet to be evaluated. Dieldrin, with its longer residual action, is capable of killing newly-hatched nymphs for a period of a month or more. Extensive spraying of *Casuarina* trees in Tucker's Town with malathion (2 pints 50% emulsifiable concentrate per 100 gallons of water) resulted in marked reduction of spittlebug numbers, indicating that large scale chemical control programmes are possible, if not altogether practical or economical.

Biological Control: Beneficial species liberated for the first time in Bermuda included the coccinellids *Cryptolaemus affinus*, released against green shield scale, and *Chilocorus circumdata*, a predator of the oleander scale.

Two species of predacious snails were released in the Colony in an effort to reduce the numbers of the phytophagous snail *Otala lactea* viz. *Euglandina rosea* and *Gonaxis kibweziensis*. The latter was a new introduction.

(Annual Report of the Director of Agriculture for the Year 1959.)

Malaria control: The Colony suffered badly from mosquito troubles during 1959. This was due mainly to the heavy and recurrent rainy periods during the early spring and summer. These rains nullified all the work previously carried out to drain off and spray natural breeding sites. Further, adequate labour was difficult to obtain at the prescribed wage level.

Work fell behind in cleaning drainage ditches and oiling and spraying marshes and garbage dumps. As an emergency measure work was concentrated on the hand-spraying of the main breeding areas such as the marshes and peripheries of the dumps. The Mosquito Inspectors intensified their survey of finding and dealing with individual breeding spots such as open wells and tanks and these measures brought some abatement.

Rodent Control: The Rodent Service continued its systematic programme during 1959 and set 26,485 baiting points in addition to supplying more than 22,500 baits and 10,370 lbs. of warfarin to the public. The estimated kill from this work was 11,168 rats and 380 mice which was 3,500 rats and 370 mice less than last year.

Insect Control: Trouble in an acute form appeared in 1959 with the widespread infestation of premises by the resistant German roach. This new insect was probably imported from neighbouring countries with vegetables and food-stuffs and it was found to be immune to all known forms of residual treatment. However, by energetic propaganda and the whole hearted co-operation of agents in Hamilton and the co-operation of owners of premises, regular and intensive mechanical fumigation with pyrethrums and synergists at last brought the infestations down to manageable proportions if not under complete control. Certain new mixtures of diazinon and pyrethrums are giving a residual control of at least one month's duration.

Aircraft disinsectisation: All aircraft are sprayed on arrival; little reliance can be placed on spraying during flight which frequently can only be described as a gesture. Two Japanese beetles were found alive; an intensive search is made from June to September for these pests and traps are set.

(Bermuda, Report of the Medical and Health Department of Bermuda for the year 1959.)

BRITISH GUIANA

Agricultural Pest Control: The insecticide dieldrin continued to be effective against the giant moth borer of coconuts which is a severe pest on plantations.

A campaign aimed at eradicating the leaf-cutting acoushi ants (Atta Spp.) was started and approximately 12,000 nests were destroyed by fogging with a mixture of aldrin and dieselene.

Outbreaks of rice water weevil *(Lissorhoptrus simplex)* occurred particularly in late sown broadcast rice. Approximately 10,000 acres of rice were damaged resulting in considerable loss in yield. Due to lack of adequate drainage and irrigation facilities, control of the pest by draining the land was impracticable. The rice caterpillar *(Laphygma frugiperda)* also caused damage to rice but control was obtained through the effective use of dieldrin.

Mosquito Control: The routine schedule of the activities of the Mosquito Control Service, involving entomological check surveys on the coastlands and spraying operations with DDT of certain strategic areas, was carried out according to plan. A total of 12,022 houses and 479 other buildings was sprayed with DDT solution on the policy of a 12-month cycle for the Interior and Riverain settlements and an 18-month cycle for the coastlands.

Routine check surveys showed as usual a predominance of *C.fatigans*. There was no trace of either *A darlingi* or *Ae.aegypti*.

During the first nine months of the year there were 161 reported cases of malaria compared with 110 for the same period in 1958.

Only in remote areas of the Interior does residual malaria still exist, involving a widely scattered population of only 30,000. It is proposed with the assistance of WHO and UNICEF to eradicate resistant pockets of malaria in the Interior by the use of medicated common salt over a period of 3 years.

Filariasis: Under the auspices of WHO, a filarial consultant Dr. H. K. Beye of the NIH, paid a visit to the Colony to assess the filarial problem. Dr. Beye was most satisfied with the steps that had been taken in the local anti-filaria campaign up to date. He will submit a report on his investigations and recommendations in the near future.

(British Guiana Report for the year 1959. H.M. Stationery Office.)

EAST AFRICA

Malaria - Pare Taveta: The evidence points to the persistence of some insecticidal effect up to at least sixteen months after the last round of dieldrin spraying. The mortality in the vector population is nevertheless insufficient to prevent a certain degree of malaria transmission. Transmission is probably still localized, and mainly associated with the construction of new huts, or due to the loss, or covering up, of dieldrin on certain of the surfaces sprayed.

Pick-up of Dieldrin by Spraymen: The first results of the investigation into the fate of dieldrin absorbed into the bodies of spraymen, given in the last Annual Report, were obtained partially in the second half of 1959. The results showed that dieldrin excretion was directly related to proved pick-up of the insecticide. However the rate of excretion after four years of spraying was small, being approximately 1% of the average daily pick-up of 100 mg. It was thus necessary to have a method of determining 1mg. or less of dieldrin in a litre or more of urine with considerable accuracy, and attention was given to improving the method of analysis originated in this laboratory.

Bilharziasis: Snail Vectors: It is now proved that *Bulinus (Physopsis) globosus* and *B. (Physopsis) nasutus* are natural vectors of human schistosomiasis in this area.

(Annual Report of the East African Institute of Malaria and Vector-Borne Diseases, July, 1959 - June, 1960.)

Tsetse

Vector Control:

The Ankole experiment, designed to test the efficiency of a particular regime of discriminative clearing as a means of eradicating *Glossina morsitans*, was concluded; it was considered that the method had little effect on the fly population. Some experiments on the persistence of insecticides on cattle were done.

The Ankole Experiment

Pilson and Harley (E.A.T.R.O. Annual Report, 1958) described the start of an experiment in discriminative bush clearing in Nyabushozi County, Ankole District, Uganda. The phase one vegetation that was considered to form the habitat of the tsetse comprised a canopy of tall *Acacia* or *Albizia* trees, with shorter *Acacia hockii* and various thicket species underneath, and short grass. The object of the experiment was to determine whether complete removal of the canopy or top storey trees of this phase was sufficient to render the country unsuitable for *G.morsitans*. The experiment was carried out in an area where partial treatment of these trees in the past had proved unsuccessful.

The clearing of the 20 square-mile western portion of the experimental area, when the fly density was relatively high, was completed in 1958 while the clearing of the 28 square-mile eastern portion, which had received more thorough treatment previously and in which fly densities were lower, was completed in April, 1959. The total area cleared was calculated from aerial photographs and from the number of trees felled, knowing the original number of trees per acre in several sample areas; the two estimates were fairly close together, the second method, giving the smaller value, has been considered the more accurate. Approximately 7.5% of the western or Rwemondo area was treated during this experiment, a total of approximately 11% since clearing began in 1955. The corresponding figures for the eastern or Nsikizi area are 2.4% and 7%. The Rwemondo clearing, in wages and rations of labourers and headmen only, cost £16½ per square mile, the Nsikizi clearing, rather over £4 per square mile.

The effect of the clearing was observed by following the catches on eleven fly-rounds within the experimental area; two control fly-rounds lay in the north-west. These fly-rounds were operated until August, 1959, and the tables below show the three-monthly Apparent Densities recorded. The clearing had no marked effect on the Apparent Densities and was in no case followed by a definite and continuing reduction. There was, however, some suppression of the rise in Apparent Density shown by the two control fly-rounds. No general increase in Mean Hunger Stage or in the percentages of female or teneral flies among the catches were observed.

Examination of the distribution of the flies following clearing showed that the concentrations now occurred in, or close to, groups of tall *Acacia hockii* trees some 12 to 18 feet tall with a more or less continuous canopy and associated with thickets and short grass. Several such groups, where large concentrations of fly occurred, were situated close to game paths on ridge tops but in other instances no clear association with the presence of game was apparent.

The identification of blood meals of the tsetse, from samples taken before, during and after clearing showed no significant change in feeding habits. From the number of mammals recorded on the fly-rounds it may be concluded that the disturbance caused by the clearing operations had little effect on the fauna. Warthog and buffalo were the predominant hosts.

Although the clearing had little effect on the fly population it seemed that it might have resulted in an increase in the general level of tsetse activity and therefore an increase in the rate of utilization of reserves. Such effect could have passed unnoticed by the routine sampling method as host animals were numerous, offering the opportunity of frequent feeding. An experiment was therefore carried out in July to compare the rate of utilization of the blood meal of non-teneral male flies from the Rwemondo area and from an area near Sanga, some 15 miles to the south-east, where no clearing had been carried out. Hungry flies were fed, marked and released, the weight of the blood meal being recorded. On recapture they were weighed again and the weight of the residual blood meal obtained and expressed as a percentage of the solids contained in the original meal. No difference in the rate of utilization of the blood meal could be detected between the two areas.

Thus complete felling of all top-storey trees of Phase 1 vegetation in Ankole does not result in eradication of *G.morsitans*, which survive at unreduced density and thereafter form concentrations in groups of tall *Acacia hockii* in Phases 2 and 4. It is clear that before substantial reduction of the tsetse population can be achieved, these tall *A.hockii* must be removed.

Groups of tall *Acacia hockii* were rare in the northern salient where discriminative clearing was started in 1952 and where partial treatment of top-storey trees of Phase 1 vegetation was followed by a 99% reduction in tsetse density over the following 3½ years (E.A.T.T.R.R.O. Annual Report, 1953, E.A.T.R.O. Annual Report, 1955/56). Such groups occur over much of north-east Ankole, where similar treatment had little effect on the fly, otherwise the vegetation of the two areas is similar. This lends support to the conclusion from the experiment that it is the groups of tall *A.hockii* that are important and that their elimination would result in a reduction in fly density. Thus it would appear worth while to test on a small scale programme of felling all trees of *Acacia sp.* and *Albizia sp.* that are over perhaps eight feet tall before discriminative treatment of the bush is abandoned as a control method in Ankole. It would seem that such a policy might well compare favourably in cost with insecticidal treatment.

Tables:- The mean Apparent Densities recorded on each flyround for three-month periods from March, 1958 to Aug. 1959.

Year	Period	Nsikizi Area-Fly-round						
		1	2	3	4	5	A	B
1958	March-May	7	19	8	2	-	-	-
	June-August	2	4	7	3	9	4	4
	Sept.-November	(3)	(6)	(7)	3	(7)	3	3
1959	Dec.-February	(4)	(7)	(17)	(5)	7	3	5
	March-May	(3)	15	24	7	6	(2)	(3)
	June-August	3	13	25	3	6	3	5

Year	Period	Rwemondo Area-Flyrounds				Control Fly-rounds	
		1	2	3	Kamalia	1	2
1958	June-August	(41)	(41)	(35)*	(10)	23	9
	September-November	(35)	(39)	(23)	4	23	11
	December-February	23	38	16	5	35	19
1959	March-May	27	39	16	9	33	22
	June-August	34	55	15	4	54	23

The period during which clearing was in progress in proximity to each fly-round is indicated by bracketed figures.

* The apparent Density for this fly-round in June, 1958 was 17, after which it rose to a maximum of 43 in July, probably due to the disturbance caused by clearing, and subsequently declined. Consequently there is little difference between the apparent densities on this fly-round at the beginning and end of the experiment.

Insecticides on cattle:

The spraying of cattle with residual insecticides could only be adopted as an anti-tsetse measure under conditions where cattle competed very favourably with wild animals as tsetse hosts, and it is doubtful if, even then, total eradication of the fly would result. It would be necessary for the herds to be maintained, by respraying, at a high insecticidal level for any appreciable reduction of tsetse numbers to result and to achieve this some previous estimates of the insecticide's duration on the cattle would have to be known. This small experiment was carried out to ascertain whether a standard method could be used to test the residual properties of dieldrin compound on an ox.

A bullock was sprayed with an emulsion of dieldrin in miscible oil at a strength of one part by volume of concentrate to 164 parts of water. Mixed batches of teneral and non-teneral *G. morsitans* originating from laboratory-hatched puparia (ex Singida, Tanganyika) were allowed to feed on the ox, two hours after spraying and every second day thereafter, for three weeks. Similar mixed batches of flies were fed at the same time on an unsprayed ox kept under the same conditions as the first ox. Both beasts grazed in paddocks during the day and were stalled at night. It rained frequently during the first eight days of the experiment, usually between 1400 and 1800 hours; 3.2 inches of rain were recorded at the laboratories during this period; only a trace of rain (0.06 inch) was recorded for the last two weeks.

The tsetse used were taken as required from uninfected laboratory batches and divided at random into two groups of males and females which were allocated randomly to the test oxen. Feeding was carried out with individual flies in 2 x 1 - inch open ended glass tubes corked at one end and enclosed with mosquito netting at the other. Each fly was brought into contact with the ox by removing the cork and inverting the tube on the animal's back or side. No contact occurred between the treated surface and the mosquito netting. Each fly was allowed to feed, or, if disinclined to do so, retained in contact with the treated surface for at least 30 seconds. After feeding, the corks were replaced, covered with clean filter paper, and the tubes kept over water, covered with a black cloth. Each batch was visited 18, 24 and 48 hours after exposure, when deaths were recorded.

The death rate after 18 hours was found to be small and the 48-hour death rate, even among control batches, too high, to discount starvation as a contributory cause of death so that the probit analysis of results was carried out using mortalities recorded after 24 hours only.

The analysis indicated that the insecticide was killing only 50% of the flies coming into contact with the ox about ten days after being applied. Fiducial limits (95%) for this LD_{50} (10.3 days) were calculated at about 9 and 12 days (actually 8.6 and 12.4 days respectively). There was no differential effect depending on the sex of the flies.

It might be concluded from these results that respraying under field conditions should be carried out weekly. Prolongation of residual toxicity by repeated spraying may enable respraying to be carried out less frequently and should be tested. The toxicity of dieldrin to the oxen was not considered at this stage.

Among other topics reported are:-

Methods:

Apparatus to feed flies individually on mice.

Laboratory maintenance of *G. pallidipes.*

Puparial production by trapped *G. pallidipes*.

Variability of flyround catches.

Siting traps for *G. pallidipes*.

Studies on traps for *Glossina*.

Ecology:

Feeding habits of *G. swynnertoni*.

Behaviour of tsetse flies.

Resting sites of *G. morsitans*.

Vegetation of Lugala area.

Wild animals in Lugala area.

(East African High Commission, East African Trypanosomiasis Research Organisation Report, Jan. - Dec., 1959.)

Filariasis investigations, Kilwa

A high incidence of Bancroftian filariasis associated with a high mean microfilarial density had previously been found at Kilwa, south of Dar es Salaam, and a field laboratory and insectary were established there for three months to investigate vector/parasite relationships.

Volunteers with different levels of microfilaraemia were bitten by *Culex fatigans* (a sample of which was weighed prior to the blood feed). Immediately following the feed, mosquitoes in another sample were individually weighed and dissected, the number of imbibed microfilariae being subsequently counted in smears made of the blood meal. The remaining mosquitoes were dissected for infected larvae at the end of the incubation period.

The results of these investigations suggest that:

(1) The weight of blood ingested was directly related to the unfed weight of the mosquito.

(2) If the weight of the blood meal and the concentration of microfilariae in the "donor" blood was taken into account the number of microfilariae which a mosquito can be expected to ingest at a blood meal can be calculated. It was found that the number of mosquitoes ingesting more microfilariae than expected exceeded those ingesting fewer.

(3) Considerable loss of microfilariae occurred during their development to infective larvae, and the percentage loss was greater when mosquitoes fed on carriers with a high density microfilaraemia than when they fed on those with lower microfilarial densities.

(4) No microfilariae were present in the dejecta passed by mosquitoes while feeding, but many were passed in the dejecta two to three days after an infected blood meal.

(5) There was a higher mosquito mortality following feeds on carriers with a high density microfilaraemia than after feeding on those with fewer microfilariae in their blood.

(6) No consistent increase was found in the infective rate of mosquitoes feeding on bloods of increasing microfilarial densities.

Bilharziasis: Molluscicides trials: A series of trials have been carried out using the molluscicide Bayer 73 and for comparison, sodium pentachlorophenate, both in the laboratory and in a number of fish ponds. Laboratory tests were carried out using the following species of snail: Bulinus (P) *nasutus p.*, B *Bulinus - coulboisi*, B. (B) *forskalii*, Biomphalaria *pfeifferi*, *B. sudanica t.* and *L. natalensis*. Snails were immersed in the test solutions in beakers for an exposure period of 24 hours, then thoroughly washed, placed in clean water and observed for a further 48 hours. The results of the laboratory tests show that in tap-water the six species of snails tested were equally susceptible to a concentration of Bayer 73 of 0.3 parts per million; comparable results using sodium pentachlorophenate were only obtained at a concentration of 3 parts per million. Snails were found to be less susceptible to solutions of Bayer 73 in distilled water. During the beaker test snails were not apparently irritated by Bayer 73, and there was no observed tendency to leave test solutions. *S. mansoni* cercariae, exposed to Bayer 73 at concentrations of 0.5, 0.3 and 0.2 parts per million were killed within five to ten minutes of introduction into the test solution.

A number of fish ponds containing populations of *B. pfeifferi*, B. (B) *coulboisi* and *L. natalensis*, also various fish genera and species, were treated with Bayer 73 and sodium pentachlorophenate at concentrations of 1.0, 0.5, 0.3 and 10 parts per million, respectively. Prior to application of the molluscicides snail populations were estimated weekly for five weeks.

Forty-eight hours after mollusciciding no live snails were found in treated ponds. Egg masses found on snail traps were removed to laboratory aquaria, but none survived. Fish were apparently distressed a short time after the molluscicides were applied, and large numbers died in all ponds during the following 24-hour period. Slight wilting of vegetation was noted in ponds treated with Bayer 73, but quick recovery took place, and pronounced scorching was evident only in the pond treated with pentachlorophenate.

It is considered that recolonisation of the treated ponds by snails began eight to nine weeks after mollusciciding. The results do not indicate any significant differences in timing of recolonisation that might be attributed to the different concentrations of molluscicides applied. Chemical analyses show that in all ponds applied concentrations were quickly reduced to trace amounts (24-hour period), probably due to absorption by vegetation and mud and ultra-violet irradiation from the strong sunlight. It is significant that a concentration of 10 parts per million of sodium pentachlorophenate was required to give comparable results in the field.

(Eastern African Institute For Medical Research Report, 1959-60). East African High Commission.

FIJI

Rhinoceros Beetle Control:

Chemical Control: In Fiji, experiments with the insecticide "Sevin" have shown that this is more effective against *Oryctes* adults than is BHC. It is also a safe insecticide to use, as its toxicity to humans is low. Provided that a satisfactory price can be arranged, it is probable that "Sevin" will replace BHC in our mixture for crown treatments.

Field Operations - At the beginning of the year, climbers were instructed to curtail their searching operations for beetles when they climbed the palms to apply crown treatments. The idea was to reduce treatment-time, and thus increase the number of palms treated per climber. Previously they searched in tunnels made by the beetles and they were told to discontinue this operation and to merely collect beetles which were readily available. However, when treating the crowns, they were to use a stick to push the BHC-sawdust mixture well down into tunnels made by the beetles. A subsequent check on tunnels treated in this way showed that beetles were killed by this treatment.

Biological Control: The work of breeding the parasite, *Scolia ruficornis* was continued throughout the year. Mr. H. W. Simmonds reports as follows:

The colony was started on the 5th of June, 1958, with 235 cocoons, obtained from the Palaus, and it has been considered advisable not to allow the number of cocoons in this nursery to fall much below this figure. During the 13 months following the introduction, 415 fresh cocoons were obtained, an average of 32 per month. In this connection it must be remembered that many of the females will wander away, so that this figure in no way represents the numbers of the next generation.

During the year under review a further 532 cocoons have been collected at this nursery, an average of 44.5 per month, whilst month by month the figures of 1960 have always exceeded those of 1959.

Colonies of cocoons have been placed at Wainadoi and Korovou in Tailevu. This latter has proved particularly interesting, because when it was opened at the end of ten weeks, whilst only eight of the cocoons had emerged, there were 27 fresh cocoons in the adjoining compost heaps. It suggests that we use a somewhat different technique in our distribution, releasing smaller numbers at the beginning, but adding to them from time to time.

It has also been found that whilst a number of the parasites go right through a generation in under ten weeks, and can thus go through several generations in the year, others go into a diapause just prior to pupating, and may remain in that condition for many months. We do not know the cause of this, which does however seem to be connected with the wet season, nor do we know what breaks the diapause, but there was a considerable flush of adult wasps at the end of June with scarcity in May and January. Yield of cocoons reached maximum in January.

The method devised for use at Dravo to prevent the escape of adult beetles from the heaps has proved quite satisfactory, and practically no beetle damage is apparent in the immediate neighbourhood.

During the year a good deal of correspondence has taken place with Samoa, in an endeavour to ascertain what value has accrued from the introduction of this parasite. So many factors however come into play that it would not be wise to make a definite statement, but the very great increase in the export of copra since the introduction of the parasite is, I consider, significant.

(Legislative Council of Fiji, Council Paper No. 24 of 1960.)
Coconut Pests, Diseases Board Report for Period 1st June 1959 to 31st May, 1960.

HONG KONG

Rodent control: The total numbers of rodents reported collected during the year, resulting from use of rodenticides, trapping, fumigation, and maintenance of public rat-bins by various government departments, including those detailed in the appendices, are summarized as follows:

Collected after poisoning	14,978
Trapped	69,264
Reported found after fumigation	759
Collected from public rat-bins	232,912
	317,913

(Report on Pest Control in Hong Kong, for the year 1959-60.)

KENYA

Public Health

Malaria Control: Records over the past 18 months have shown a reappearance of malaria at the periphery of the Nandi district, notably in the Kaptumo and Kabiyet areas. The picture has been confused by the appearance of influenza, and the clinical diagnosis at the dispensaries has not proved a reliable guide. Malariometric surveys have had to be reinstituted and show an overall parasite rate of less than 5% in children under the age of 10. Entomological surveys, however, indicate no increase in hut mosquito indices. Present policy is to assess the long term efficacy of the daraprim/dieldrin campaign, but should a serious break through occur, it is proposed to cut short the growth of an epidemic by the mass administration of darachlor.

Wakamba are being resettled in an area known as the Shimba Hills in Kwale district in the Coast Province. The high incidence of malaria in these semi-immune people has been a constant worry. Hut spraying has been ineffective. As an alternative, mass treatment with darachlor was started in December, and the initial results are encouraging.

Filariasis. Human and entomological investigations by the Division of Insect-borne diseases during the year have shown that although *Culex fatigans* is an important vector of *W.bancrofti* in the Northern part of Kenya Coast, *A.gambiae* and *A.funestus* are the more important vectors further south. The infection rate in the human population seems to be in the region of 20% in certain parts of the coastal strip. Control measures by drug prophylaxis and elimination of the vector continue.

Onchercerciasis: With regard to onchercerciasis, surveys reveal that *S.neavei* is still absent from all the previously infested, but treated areas in Nyanza and the Rift Valley Provinces. Only a small part of Kenya on the Uganda border, near Mount Elgon remained infested. The South Nyanza district has now been free of *S.neavei* for seven years and North Nyanza for four years. A census of the blind has recently been undertaken in Nyanza Province, and the first report from Kericho has revealed that out of some 200 blind persons, whose disability can be ascribed to onchercerciasis only six were children under the age of 10. Apart from the observed absence of the responsible vector, this last evidence is a good indication that the disease has been brought under control, if not eradicated.

Bilharzia: Bilharziasis has long been known to be endemic in Kenya. *S. haematobium* is prevalent mainly along the Coast and in the Tana River valley, Kitui, and Central and South Nyanza districts, whilst the double infections of *S.mansoni* and *S.haematobium* exist in Taveta, Ukambani, Nairobi and environs, and around the Lake Victoria basin.

Indications are that some 15% of the population is probably infected with *S.haematobium* or *S.mansoni*. If irrigation schemes are to become an important feature in the Colony, then bilharzia cannot be ignored.

Sleeping Sickness: The incidence of human sleeping sickness in Kenya has steadily fallen from 117 cases in 1950 to 38 in 1959. Complete success in the control of *G.palpalis* and the gambiense form of human sleeping sickness is in sight, provided that sufficient finance can be made available. However, there is little room for complacency since the rhodesiense form of the disease carried by *G.pallidipes* has been reported from the western borders of the territory and unless adequate control measures are vigorously pursued, this more serious type of the disease may spread inwards from Uganda. An experimental attempt has been made to control *G. pallidipes*, the responsible vector for this and the cattle disease, on Sikiri promontory nn the South Nyanza shores of Lake Victoria. Traces, 200 yards apart, have been cut in the bush and have been sprayed from the paths with dieldrin insecticide. Results have been promising and the fly density has fallen from 188 to 1.8 catches per man hour. An extension of this cheap and effective method of control is planned on the mainland in those parts of the country where the risk of spread of rhodesiense infection from over the border is the greatest.

Aircraft Disinsectisation: Some 239,000 arriving, departing and in-transit passengers passed through Nairobi airport during the year. Aircraft movements totalled 6,200. The Central Government is the Port Health Authority for this large airport, administering these duties through a part-time port health officer, a resident port health inspector and a nursing sister with auxiliary staff.

Mosquito control measures are rigidly enforced and a large number of permanent breeding places have been eliminated, leading to a significant reduction in the number of culicine mosquitoes. No *aedes aegypti* were found.

Rodent Control: Stringent anti-rodent measures were maintained at Mombasa Port and 4,597 rats were trapped, a proportion of which were examined for plague. All findings were negative.

(Ministry of Health Annual Report 1959.)

Agriculture

Cotton Stainer: A trial to compare dust formulations of malathion and endrin with DDT and BHC showed clear differences in their effects on insect populations during the dusting period and on the earlier pickings, but later pickings in the rather extended harvest (due to the May-July drought) tended to reduce the differences in the final yield. From the results shown below it is seen that BHC gives the best control of stainers, with malathion second, DDT and endrin having little or no effect.

Live and Dead Stainers Per Acre, Dusting Trial, Kibos

Variety - S47. Planting date - 9th April. Layout - randomised blocks separated by undusted strips. Replications --4. Plot size--96ft x 66ft, Dusting dates - July 23, August 4, 12, 23, September 9.

Treatment	Dead stainers 24 hrs. after dusting	Live stainers at weekly counts during dusting period
3% gamma BHC 10% DDT	6111	761
3% malathion 10% DDT	1674	1015
1% endrin 10% DDT	948	1722
1% endrin 3% malathion	1311	1274
Control	20	2467
S.E.	±117	±45

(Kenya Progress Reports from Experiment Stations, Season 1959-60) Kenya. Published by the Empire Cotton Growing Corporation, London, 1961. pp14.)

MAURITIUS

Malaria Control: Malaria, which up to 1945 occupied the first place amongst causes of mortality, has now ceased to be a public health problem and the figures shown below indicate the remarkable fall in the death rate due to malaria:-

Year	Deaths ascribed to malaria	Rate per 1000 population	Percentage of deaths due to malaria to total deaths
1945	3,534	8.34	23.13
1948	1,580	3.58	15.02
1951	285	0.59	3.95
1952	188	0.37	2.52
1953	61	0.12	0.73
1954	27	0.05	0.32
1955	3	0.00	0.04
1956	Nil	Nil	Nil
1957	Nil	Nil	Nil
1958	1	0.00	0.01
1959	Nil	Nil	Nil

(Report on Mauritius, 1959. Her Majesty's Stationery Office 1961.)

NORTH BORNEO

Rice: The padi leaf hoppers, *Nephotettix bipunctatus* and *Nepicalis spp;* were successfully prevented from stunting young padi in the Districts of Penampang, Putatan, Inanam, Mengattal, Telipok and Papar by application of BHC (0.65%) dusts with rotary dusters in May and June. The Armyworm, *Spodoptera manuritia,* invaded some 400 acres of padi land in the districts of Penampang Mengattal, Inanam, Putatan, Kudat, Kota Belud and Keningau. Some 300 acres of maize crop at Kudat was also invaded. The pest was successfully brought under control with sprays containing 0.10% dieldrin. *Agrotis spp.* also occurred as pests of padi and were brought successfully under control similarly. The rice bug *Leptocorisa acuta* occurred at usual sequence in the padi season and its damage was successfully prevented by the timely application of 0.65% BHC dusts as in previous years. The padi stem borers *Schoenobius incertellus*, *Chilo chaphalocrocis medinalis*, and Nymphalid caterpillar *Cyllo leda* were minor pests of padi and were successfully brought under control. The control of these pests was greatly assisted by the preparation, often at short notice, of posters and leaflets showing the details of the protective methods to be adopted.

Coconuts: The coconut nettle caterpillar *Setora nitens* reoccurred in the dry season at Tawau and Kudat. A further six Local Committees were organized to deal with its control. Destruction of undergrowth with hormone weedicides was extensively demonstrated in coconut areas in order to induce sanitation practice against breeding of the pest. Breeding of the Tachinid larval parasite *Chaetexorista javana* was carried out as biological control. Lead arsenite spray was used successfully against the caterpillars and lamp traps for the moths. Minor outbreaks of the red stripe weevil *Rhynchophorus schach* and the rhinoceros beetle Oryctes *rhinoceros* were brought under control with sprays containing 0.20% dieldrin.

Cocoa: The ring borer, possibly *Phassus damor*, and the coffee stem borer, *Zeuzera coffeae*, occurred as minor pests of cocoa occasionally. Successful control was obtained by cutting and burning infested trees to destroy borers and spraying the uninfested trees in the vicinity with 0.20% dieldrin or endrin at intervals of two weeks until control was achieved. Inserting crystals of paradichlorebenzene into the tunnels of these borers was also a useful means of control.

Locust Control: Minor outbreaks of the Oriental migratory locust, *Locusta migratoria manilensis* occurred during 1959. Periodical patrols carried out during the year since April stopped several locust infestations which could have become major outbreaks later if they had not been destroyed promptly. The minor locust outbreaks which had been successfully brought under control were located at Jesselton in June and in Kudat and Semporna Districts in August. Spraying teams equipped with light hand sprayers using dieldrin operated under the supervision of the Government and the co-operation of village headmen contributed to the success of the control campaign as in previous years.

Cats; Cats play a very important part in the economy of the kampong in that they keep down rodent pests. This has been very notably demonstrated with the introduction of residual spraying of insecticides in all kampong houses in the malarial control campaign. These insecticides are highly lethal to cats and to a smaller extent poultry and although when spraying is taking place owners are advised to shut up their animals they rarely do so. The result is that practically the entire cat population in certain areas has been wiped out with a resultant rapid increase in the rat population. In one or two areas this has become so great that it has had a marked effect on the storage of padi and other cereals.

(Colony of North Borneo, Annual Report of the Agricultural Department, 1959.)

Rodent Control: Field rats were a greater menace than usual, partly as a result of antimalarial spraying which accidentally killed many cats; baits poisoned with zinc phosphide were used against rats and 42,000 were killed in pre-planting and post-harvesting campaigns.

Malaria Control: The project mentioned above for the control of malaria and sponsored jointly by the Government, World Health Organisation and United Nations Children's Fund began in mid-1955. The malaria map of the Colony shows that in most rural areas malaria is hyper-endemic. Although it is probable that one anopheline mosquito is almost entirely responsible for the transmission of malaria, there is no doubt that other mosquito carriers may transmit the disease in restricted areas, for example, near the coast. By the end of 1959 both active and passive surveillance were in progress in the island of Labuan where no case of malaria could be found during the year despite an active search. Reports from the Interior Residency indicate that in many places the control campaign has been successful and that the health of many of the rural public has been much improved. A further expected result has been that there is a report of many more Murut children than formerly. The Murut population had been declining for some years past and it was hoped that the control of malaria would go far to halt this process. The Census planned for 1960 will no doubt give valuable information about the success - as regards infant mortality - of the Malaria Control Project. During the year 1959 it is estimated that over 32,000 houses were sprayed and that a population of 130,000 persons was protected. 1960 will be devoted to a consolidation of the spraying programme as carried out in 1959 and to a thorough review of present results with the intention of drawing up a plan for the eradication of malaria from the whole Colony beginning in the year 1961.

(North Borneo 1959, H.M. Stationery Office.)

NORTHERN RHODESIA

Snail Control: The Board sought the advice of a small technical sub-committee as to whether the incidence of bilharizasis and liver fluke in the Territory was such as to justify any wide-scale control campaign, as had been undertaken in Southern Rhodesia. The committee was of the opinion that although bilharizia snails were present in most dams and watercourses and that the disease was extremely widespread it did not present as great a menace to health as malaria for example, and that, for the time being at any rate, available funds and effort should be concentrated preferably on the latter disease. Liver fluke is prevalent in many herds of cattle but may be controlled by prophylactic measures taken on the farm level. A further and conclusive consideration was that as river catchment areas in the country are so large and complicated, any snail eradication campaign would be a major and expensive undertaking. The Choma, North Broken Hill, North Lusaka and Chingola Intensive Conservation areas are being assisted by the Federal Ministry of Health to carry out pilot schemes, while one or two other areas are considering campaigns on a strictly limited local scale.

(Northern Rhodesia, Ministry of Land and Natural Resources, Annual Report of the Natural Resources Board, for the year, 1959.)

RHODESIA & NYASALAND

Trypanosomiasis: The trypanosomiasis situation in the south-eastern lowveld continued to deteriorate and the danger is now as great as when the Zambezi tsetse belt began to expand forty-five years ago. Elsewhere the situation has remained unchanged or has started to improve.

The field Research Station at Kariangwe has been closed down and a new one opened in North Lomagundi, half a day from Salisbury.

Game destruction is still the major control technique. Labour expenditure was: Hunting 32%, traffic control 18%, bush clearing and control 17%, fencing 13%, road construction 8%, miscellaneous 12%. This however does not show insecticides in their true light, where expenditure on pesticide and machines was five times that of arms and ammunition.

(Report of the Director of Tsetse and Trypanosomiasis Control and Reclamation for the Year ended 30th Sept., 1959. Federation of Rhodesia and Nyasaland.)

ST. HELENA

Agricultural Pest Control: Cut worms are severe pests of most vegetables and the foliage caterpillar *Prodenia litura* attacks many as well. French beans suffer from red spider and birds and rats also cause damage. Aphids are pests at times particularly *Brevicoryne brassicae* and *Myzus persicae* on brassicas. Potatoes suffer in dry seasons from the tuber moth *Gnorinoschema operculella*. Bananas, particularly Cavendish, can be attacked by *Opogona subcervinella*.

P. litura attacks most deciduous fruit but it should be noted that the codling moth is absent from the island. Mediterranean fruit fly is present but does not cause much damage to apples and pears. False codling moth *Olethreutes leucotreta* causes damage to fruit.

Citrus was once exported and is now poor due it is thought to pests - psyllid, *Trioza erytreae*, aphids *Toxoptera auranii* and *T. citricidus* (thought to transmit tristeza). Coccids are numerous particularly *Lepidosaphes beckii*, *Aonidiella citrina*, and *A. aurantii* the red scale. Rats and birds destroy much fruit. Coffee is not much attacked.

"Hogworms", larvae of *Mellissius*, cause patches in pasture.

Phormium flax is not attacked by pests.

There is some termite attack on trees and eucalyptus is attacked by the snout beetle *Gonipterus scutellatus*. There is the usual range of stored products pests.

Cattle are attacked by the ticks *Rhipicephalus evertsi* and *B. decoloratus*, and the stable fly, *Stomoxys calcitrans*. The sheep ked, *Melophagus ovinus*, and blowfly *Lucilia sericata* are found.

Control measures advocated are quarantine measures to prevent the introduction of pests not yet present in the island and introduction of certain parasites. The use of pesticides is difficult because of the poor returns crops give growers, and the danger of gluts and theft.

Recommendations for spraying are:- dusts of sulphur/lime against red spider or spraying with 2,4,5,4 - tetrachlorodiphenyl sulphone at 1 fl. oz. to 25 pints water. Spraying with emulsion DDT at 0.1% or dusting with derris or pyrethrum dusts or sprays can be used against caterpillars, DDT against thrips and BHC as bait against cutworms.

Hogworms in pasture should be controlled by working 5% DDT dust into the soil at the rate of 25 lbs. per acre.

(Report on an Investigation of Agricultural Pests in St. Helena, 1957 - 1959., C. R. Wallace.)

ST. VINCENT

Bananas: Low volume, oil-based spraying, employing "Motoblo" machines, has increased control of leaf spot disease (Cercospora), and all banana plants have been regularly sprayed and dipped with aldrin. The bananas are now in far better condition, and production should easily be trebled in the next year or two.

Yellow Fever Control: The campaign for the eradication of the vector *Aedes aegypti* which began in March, 1955, under the auspices of WHO/PASB, made good progress throughout 1956 and 1957. The whole island and the Grenadines, with the exception of a small area in Bequia, have shown negative readings for at least two consecutive 12-week checks. "Vigilance Inspections" will continue throughout 1958 and it is expected that it will be possible to declare St. Vincent free of the mosquito, and of the possible hazard of an outbreak of yellow fever, a disease which has been unknown in the island for many years.

(St. Vincent, Report for 1956 and 1957. H.M. Stationery Office.)

Sarawak

Agriculture

Rice: The most widespread and serious pests were again army-worm *(Spodoptera mauritia)*, and rats. There has been a steady increase in the use made of the Department of Agriculture's free pest control service.

Coconuts: The most serious pest of the coconut palm is still the Rhinoceros beetle.

(Sarawak, Annual Report for 1959.)

Malaria Control: The anti-malaria programme has continued to be the most important mass health campaign in the country, and progress was considerable during the year. Transmission still continues to a very limited extent, but the aim of total eradication of the disease has come nearer realisation. By the end of 1959, every known malarious area in Sarawak had been sprayed, at least once, and three areas, had been brought under active surveillance.

The present situation can be summed up by the statement that very satisfactory control of the disease has now been achieved, but a concentrated effort will be required during the next three or four years, to achieve the goal of total eradication. Plans were prepared at the end of the year, by the World Health Organization Malaria Adviser with the help of the World Health Organization Regional Sanitary Engineer for the conversion of the control scheme to one of total eradication of malaria from the whole country. To achieve this, the fullest co-operation of the public must be obtained, and steps are being taken to give the eradication campaign the widest publicity possible.

The idea which appears to be prevalent in some quarters, that the fight against malaria is already over, must be firmly scotched. We are only now entering the most intensive and difficult phase of the whole campaign - the phase of active, country-wide surveillance. On the success of this phase, which will last about three years, will depend the success of the whole eradication campaign. It is hoped to obtain financial help from the Malaria Eradication Special Account (MESA), and the World Health Assembly has voted the sum of U.S.$150,000 yearly, for three years, to assist Sarawak, during the phase of intensive surveillance. Unfortunately funds in the special account are low and it is not yet known if this money will be available or not.

During the year, building of the new anti-malaria headquarters near the Sarawak Mental Hospital, was started and it is expected to be ready for occupation, early in 1960. It will contain central laboratories and will also house the first and second Division spraying and surveillance teams.

(Sarawak 1959, Annual Report, pages 96 - 97.)

SEYCHELLES

Melittomma: Nearly all the palms which had previously been treated with paradichlorobenzene were found to contain residual infestations, and had to be opened up, regouged and painted with creosote-tar mixture. The degree of infestation remaining after this retreatment is very low and amounts to about five or less larvae in approximately 2% of the palms. At this level it is unlikely that a male and female beetle will emerge together during their brief adult life which lasts less than a week. It will however be necessary for a small team to continue to inspect the Praslin palms at about two yearly intervals to eliminate any remaining infestations which may develop.

(Annual Report of the Department of Agriculture for the Year 1959.)

TRINIDAD AND TOBAGO

Forest pests: The main insect pest was the leaf-cutting Bachac or Parasol ant (Atta sp.). Control measures were undertaken by spraying with dieldrin and aldrin. The shoot borer, *(Hypsipyla grandella)* of Cedar, *(Cedrela mexicana)*, Mahogany *(Swietenia macrophylla)* and Crappo *(Carapa guianensis)*, caused damage through loss of growth and malformation of the affected trees. Defoliation of Serrette *(Byrsonima spicata)* and Marouba *(Simaruba amara)* by the larvae of the moth *(Atteva pustulella)* continued.

Damage to trees by wild animals and birds was negligible.

(Trinidad & Tobago, Administrative Report of the Forest Dept. for the year 1958.)

UGANDA

Crop Pest Control

Cotton: It is now known that spiny boll-worm is also controlled with DDT and recent trials have confirmed that no modification of the method originally designed for the control of *Lygus* bug is necessary in the light of this knowledge. During 1959 farmers sprayed 14,000 acres against cotton pests compared with 6,000 acres in the previous year. Lack of rain in the first half of the year resulted in much of the crop being planted too late to make spraying worth-while; in the circumstances the acreage treated is regarded as a very satisfactory achievement. The greatest progress was made in Teso District where it is estimated 7,000 acres were sprayed.

Coffee: Owing to the serious loss of crop from insect attack and following on comprehensive trials conducted by the Research Division, spraying against *Antestia* was carried out by trained gangs. Experimental spraying against lace bug was carried out on a full scale. The total acreage treated against the two pests was 1,436 acres. A special drive was undertaken to encourage the complete picking of "buni" to reduce the heavy berry borer attack, and the amount of "buni" sold rose to 424 tons.

Stored products: Experiments into the control of bean pests are in progress using three varieties, Mutike, Banja and Canadian Wonder. The first two are very susceptible to bruchid attack but the last appears to have considerable resistance. Irrespective of variety, damage to beans treated with 0.04% gamma BHC to the level of 1 p.p.m. of the dried beans is very slight.

Fumigation experiments on maize stacks using methyl bromide have been carried out in co-operation with the Empire Cotton Growing Corporation at Namulonge. One stack was covered with a large americani bag before treatment and on another, a large polythene sheet was left *in situ* after treatment to try to prevent reinfestation from outside.

After five months, control still appears to be complete.

A trial using a plywood silo for maize is also in progress but several disadvantages have become apparent which may limit the use of such silos under Uganda conditions.

Machinery: Two large-scale trials of the "Conomist" air-blast were carried out in co-operation with the Special Development Section, one in the Western Province under almost ideal conditions and one in the Northern Province under very difficult conditions. In both these trials an adequate level of insect control was achieved.

Trials with the "Motoblo" sprayer conducted in Eastern and Western Provinces resulted in the introduction of numerous modifications which have improved performance and eased maintenance. Comparative trials are being undertaken to evaluate four other types of motorised knapsack sprayers. Improvement was also effected in the design of the long-boom sprayer used for large-scale cotton experiments, and it is now possible accurately to spray an acre of experimental cotton in three-and-a-half minutes.

(Uganda Protectorate, Annual Report of the Department of Agriculture, for the Year Ended 31st December, 1959.)

Cotton

Tetranychus: Once again *Tetranychus* caused extensive defoliation on cotton grown under conditions of supplementary irrigation which had received 6 applications of DDT sprayed at low volume with 1 lb active ingredient per acre. Two applications of 0.5% "Delnav" (an organo-phosphate) at 8-10 gallons per acre and with an interval of 10 days, failed to arrest development of the mite.

Stored Maize

Insect pests: The method of Coaker (1959) is suitable for the control of insect pests of stored maize for a period of 6 to 8 months. The use of polythene sheeting as a mechanical barrier to re-infestation has been investigated, in an attempt to extend the effective storage period, but even during the very short time that the sheet is removed for maize sampling, insects gain entry to the stack with the result that the maize suffers rapid deterioration.

Trapping

The collection of the large numbers of insects needed for study requires means of trapping them. It is known that certain insects are attracted to particular colours (e.g. Hemiptera in general and *Bemisia* spp. in particular to yellow). Glass plates painted on one side, green, yellow, blue, red and white, and on the other coated with an insecticidal adhesive, were placed in a cotton plot and the catch was removed at intervals of 48 hours.

(Progress Reports from Experiment Stations, Season 1959-60. Uganda.)

ZANZIBAR

Tick-Borne Diseases: Dipping against tick-borne diseases continued to be employed by the commercial dairymen operating near Zanzibar town and also for the Department's cattle at Kizimbani and Hanyegwa Mchana. In Pemba, some 35 privately-owned animals were dipped weekly at one of the three dips in that island, as compared with 50 in 1958. The number of cattle brought to be sprayed on the other hand, increased markedly in Pemba, although no new areas were covered. Both the dipping and the spraying services are provided entirely free and it seems that expansion of the latter will be limited only by the extent to which Government is prepared to finance a free service or the extent to which cattle owners are prepared to pay for it. The average numbers of animals sprayed per week are shown in the following table.

	1959	1958	1957	1956	1955
Zanzibar	922	909	619	568	248
Pemba	843	469	295	165	-
Total	1,765	1,378	914	733	248

Gamma BHC was in general use for the district spraying, but toxaphene was introduced and was used in alternation with it at the Tunguu ranch, where it was found that incomplete protection was given and a number of animals, including imported Boran bulls, succumbed to East Coast fever. This occurred when it became necessary to graze the herds outside the ranch for a period. Elsewhere in those parts of the country where spraying has been in progress for some few years now, East Coast fever is still present but is of mild virulence with very low mortality. It is of interest that although babesiosis is not a very important disease amongst native cattle kept in the rural environment it is invariably severe when it occurs in the grade animals of the commercial dairy herds and in the dipped or sprayed Zebu herds belonging to the Department. So far there are no positive signs of resistance in cattle ticks to the acaricides used, and the village cattle owners are satisfied that the animals remain reasonably free from tick infestation. But it is known that BHC which has now been in continuous use for some years in dog dips and in dog baths in private homes has been losing its effect on the common dog ticks *Rhipicephalus sanguineus* and *Haemophysalis leachi*.

Stored Products: Ninety-seven vessels were inspected, as compared with 198 in 1958, and 26 were found to be carrying *Trogoderma* as compared with 18 only during the previous year. The 65,789 packages of infested goods or goods in close contact with them were fumigated in lighters by the London Fumigation Co. (Africa) Ltd., in 21 fumigation jobs. Fumigation consisted of exposure to methyl bromide at a concentration of 3 lb. per 1000 cu.ft for a minimum period of 24 hours.

Most of the consignments of spices, especially of coriander, cumin and turmeric from India were found to contain *Trogoderma*. One consignment of 1,805 bundles of wet dates from Muscat and Basrah were found infested through the use of old rice gunnies as covers. This was the first time that *Trogoderma* had been found in cargo from the Persian Gulf.

Godowns and mills in Zanzibar town were inspected for *Trogoderma* infestation. Altogether 116 inspections were made and *Trogoderma* was found in two godowns, in both cases in a small consignment of pulses. The contents of both godowns were fumigated. A few godowns were heavily infested with *Oryzaephilus surinamensis* and other pests and 54 of them were sprayed with malathion with good results. Twenty lighters were also sprayed.

Shipments of Burma rice were invariably found to be infested with *Trogoderma*, whether they came direct or were loaded at Singapore after being fumigated there. Some shipments of rice imported into the Protectorate were found free from *Trogoderma* but carried large populations of other insects, particularly *Calandra* spp., *Oryzaephilus* spp. and *Tribolium* spp. Consignees treated some 1,575 tons of such rice by dusting the outside of the bags with lindane 0.5% while taking delivery from the Customs import shed and a further 1,000 tons were so treated in godowns. Bundles of dates in hessian covers were also treated in a similar manner. This insecticide as well as an 0.04% dust for mixing with infested grain, was purchased by merchants from the Department at cost price. Altogether some 1,700 lb were bought.

(Annual Report of the Department of Agriculture for the Year 1959.)

NEWS ITEMS - OTHER PARTS OF THE WORLD

HAWAII

Rodent Control

New Baits: In work already initiated, the problem of the new populations is being attacked through the development of new baits and bait dispensers. Laboratory testing of potential carriers has continued unabated during the year, but nothing more promising has turned up than the milk-bone dog biscuit which was discovered in 1958. Fortunately, this material appears to be equally palatable to all four rat species and is manufactured in several forms. Lately it has become available in the form of very small oyster biscuits, which should greatly improve the economy of its use in aerial application.

Other possible carriers which were tried in 1960 include rejects of almonds, peanuts, walnuts, and macadamia nuts, plus a long list of commercial pet foods in pellet, kibble, or meal form. Some of the new materials can serve special purposes, but none were found suitable for large-scale plantation use. However, a combination of two well-tried materials did show promise. This is a combination of raw sugar and rolled oats, tightly compressed into cakes of proper size and shape for convenient distribution by hand machine. In preliminary tests, such cakes have proved considerably more palatable to laboratory rats than warfarin with rolled oats alone. Research on bait dispensers of greater efficiency than those in current use has resulted in several new designs.

Use of Dyes: An approach to the problems posed by new populations involved the feasibility of coloring the tissues of five rats by means of dyes introduced into their food. Thirteen dyes were tried in combination with milk-bone dog biscuit and rolled oats. Five, Sudan black B, Sudan green, Sudan 111, Sudan IV, and Oil Red O, all oil soluble dyes, coloured various tissues intensely and permanently enough for our purposes. Sudan black B proved much superior to the others; when this material, in rolled oats, was fed to laboratory rats for five days their skin and other organs retained a dark bluish tinge for longer than two months. It is planned to colour large numbers of rats in the field and, by trapping them at various intervals of time and space, to clarify our understanding of their daily and seasonal movements. This knowledge will be essential to the efficient conduct of control measures.

(Experiment Station, Hawaiian Sugar Planters' Assoc. 1960 Rep.)

JORDAN

Control of Cutworms: Early sowing of berseem has the advantage of getting an early cut before December when no other green forage is available. This gives it a high value; besides it does not affect the number of cuts which will be obtained later. The attacks of the cutworms, however, which affect the early sown berseem mostly do not encourage such early sowing unless adequate precautions of insect control are taken.

The cost of treating one dunum[†] is about 540 fils[‡] when the seed is treated and about J.D.2 when soil is treated. Thus by using seed treatment and early sowing a farmer can get that extra early cut without much extra cost.

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1 dunum = 1196 sq. yds.

1000 fils = 1 Jordan Dinar (J.D.) = £1 sterling.

Results of Insecticide trials:

The following treatments were carried out:-

1. Of the soil with aldrin dust at the rate of 1kg. for each 100 sq.m. of land. The dust after diluting three times with sand is scattered and mixed with the soil before sowing.

2. Of the seed, with "Binarin" at the rate of 5 grs. to 100 grs. of seed to be mixed just before sowing.

3. 1 + 2 together.

Each treatment was replicated three times. Comparison was made with neighbouring plots left untreated or treated with "Metasystox" at 0.3% and 0.6%.

Sowing was done on 15.9.58, the earliest date which proved to give best yields while the crop is subject to attack. Results are shown in the accompanying table.

(Eight Annual Report 1959 of the Deir Alla Research Station.)

The Control of Cutworms On Berseem.

1958/59

Treatment	Yield kgs. per du.						yield	kgs/du
	1st 5.12	2nd 10.1	3rd 7.2	4th 19.3	5th 14.4	6th 10.5	Green Foliage	Seed
Soil Treatment	687	580	622	617	738	830	4074	35.6
Seed Treatment	688	578	638	725	700	806	4135	34.3
Soil and Seed Tr.	838	624	658	741	743	713	4317	38.3
Metasystox Tr. 0.3%	363	427	467	637	690	783	3267	37.4
Metasosystox Tr. 0.6%	110	187	523	503	717	763	2693	27.9
Control	173	283	437	845	843	907	3488	34.8
S. E. ±							40.9	kgs/du
L.S.D. 1%							233	"
5%							149	"

POLAND

Mosquito Control: **Karsiborz Island:** The underbush of the forest was sprayed with "Azotox" DDT in a 2% water emulsion, in a belt 20-40 metres wide along the built-up residential area to protect the settlement from an invasion of the mosquitoes from the near-by breeding grounds.

It was proved that a mosquito plague could be successfully combatted by simple and easily accessible means given an accurate knowledge of the mosquitoes' mass breeding grounds and with action undertaken when the mosquitoes are still in the larval stage.

Sizing of Aerosol Particles: A 2% solution of gentian violet was sprayed on to a medium in a uniform stream of oxygen at 0.8 atmospheric pressure with an air flow of

5-6 litres per minute. After spraying, the medium, consisting of 1pt. vaseline to 2pts. paraffin, was placed under the microscope and a picture was made with a micrometric scale in the background. The size of the particles was determined with a projector and a properly prepared scale. The use of microphotography permitted the investigation of a very large number of aerosol particles. The size of 34,578 particles was determined. The medium used insured the particles against deformation and size changes. The atomizers in use produced aerosols with particles of uniform size from 49.11 to 73.48%.

This procedure enabled the determination of the size of aerosol particles, and the standardization of atomizers necessary for research on aerosols to be carried out.

(Prezeglad Epidemiologiczny, Kwartalnik, Rok XV 1961). Panstwowy Zaklad Wydawnictw Lekarskich.

SOUTH AFRICA

Wattle Bagworm

Chemical Control: During 1959 - 60 over 7,000 acres were surveyed and some 5,800 selected for aerial treatment. In all 6,142 acres were sprayed and the execution of the application supervised over 4,700 acres. The insecticide used was toxaphene dissolved in light diesel oil at the rate of 0.75 lb. in 1 gallon of solution, and 1,955 acres were treated with 2 gals./acre and the remainder with 3 gals./acre. The campaign started on 9th and ended on 30th November, 1959. In all, there were 14 spraying days with an average daily total of some 440 acres.

The general outcome of the spraying was satisfactory where plantations were properly flagged. Parts of some plantations showed an unsatisfactory kill mainly due to very dense bagworm population.

Biological Control: The outcome of experiments carried out during 1958 was assessed and it was found that with a light infestation in the first year of the prodromal stage and the larvae newly-hatched or in their second or third instar at the time of treatment, bagworm from plantations far distant (160 to 200 miles) from the experimental areas caused a significantly higher mortality throughout than did any others. Viruses from plantations at intermediate distances (20 to 40 miles) initially gave a greater kill than did local virus or that from the thornveld, while the virus of the bollworm *(Heliothis armigera* (Hbn.) though giving a kill higher than in untreated plots up to three months after spraying, was less effective than any bagworm virus. With a heavy infestation in the second year of the prodromal stage and the larvae in the first instar at the time of spraying, mortality was significantly higher only initially with virus from the greatest distance than with any other bagworm virus. In later evaluations, there was no significant difference in any of the treatments with bagworm viruses, and throughout they were more effective than virus from the cotton bollworm. These results suggest that different strains of the virus exist and that a given population of bagworms differs in its susceptibility to these virus strains.

(Wattle Research Institute, Report for 1959 - 60, Oct. 1960).

Forest Pest Control: In the Western Cape Region *Nudaurelia cytherea* infestation was light and pigs seem to have this pest under control. On account of the satisfactory results obtained from spraying undertaken by aircraft in 1956/57 it is intended in the coming year gradually to decrease and eventually eliminate the pig stock. Thereafter infestations will be controlled by aerial spraying.

The Forest Entomologist discovered a very serious concentration of *Nudaurelia Cytherea* in private plantations in Swaziland and the adjoining districts of the Transvaal from the neighbourhood of Amsterdam in the south to Barberton in the north. Over the greater part of a private plantation, an area of not less than 50,000 acres, *Nudaurelia* has been building up over a period of about three years and the concentration is now so great that if only 1% of eggs were to hatch during the coming season, the infestation will be sufficient to defoliate the whole plantation of 70,000 acres.

Euproctis terminalis is still present in the Jessievale and Umpilusi plantations and is again building up. A fairly heavy infestation may be expected in 1959-60.

(Annual Report of the Department of Forestry for the Year ended 31st March, 1959.)

SOUTH AMERICA

(1) Cacao Insects in Costa Rica: A report on entomological studies in progress in Costa Rica is presented. The major lines of investigation include.

1. Study of Insecticides.

   (a) Examination of systemic insecticides as a possible means of control of cacao insects.

   (b) Determination of the effects of insecticides of the usual type (dieldrin and DDT) on cacao insects, pollination and production when applied regularly alone or in combination with a fungicide (Bordeaux).

2. A study of the ants present in cacao and their relationships with other insects.

3. A general study of the insects inhabiting the cacao tree.

The method developed for making quantitative insect collections from seven ecological niches on the cacao tree is described. Detailed studies are now in progress to determine the role of insects on pod growth and the wilting of cherelles, and the possible relationships of insects and mites with cushion gall.

Sixteen systemic insecticides were screened first by studying their relative rates of absorbtion through the roots of young cacao trees. As a result of this screening, "Thimet", "R-6199", "Demeton" and "Isolan" were selected for study in mature cacao along with "Dimefox".

T. C. Allen, S. S. Cassida, R. D. Shenefelt. Septima Conferencia Interamericana de Cacao, Palmira - Colombia 1958 p. 221-229.

(2) "WL 1650 Insecticide for the Control of Cacao Xyleborus Trunk Borers: The *Xyleborus* trunk borers in cacao constitute a serious pest. It had been thought that possibly these insects are vectors or closely related with the presence of canker lesions produced by the pathogens *Phytophthora faberi* Maubl. (Canker of the trunk) and the *Ophiostoma (Ceratostomella) fimbriata* ("pudricion azul" or blue rot).

The attack of Xyleborus produces the death of the tree during a relatively short time which, of course, will be still shorter when in conjunction with the fungi diseases.

Modern chlorinated insecticides have been used in the control of these borers, good results having been obtained, especially with aldrin and dieldrin. These products have been recommended due to the fact that same do not cause unfavourable effects on fructification.

This work registers the trials carried out with endrin and the new chlorinated insecticide "WL 1650" in which considerable degrees of protection of trees against *Xyleborus* in the Palmira zone were obtained.

The treatment with 1.4 lbs. of "WL-1650" per acre was noticeable in the trial, giving a protection of 93.7% of treated trees after 10 months.

The application of chemicals on the trunks did not appreciably effect the flowering or fruit bearing, also it did not allow predatory ants to climb up the trees, thus permitting a considerable development in the infestation of mealy bugs in the upper parts.

The abundant and even precipitation which occurred in the experimental field during the trial suggests a high persistence of the applied chemicals, which, according to the author, could possibly be increased with the addition of special stickers, it being thus possible to reduce the dosage of active material.

M. R. Gonzalez.
Septima Conferencia Interamericana de Cacao.
Palmira - Colombia, 1958 p. 245.

(3) **Notes on the Control of Xyleborus in Cacao:** Attempts to control *Xyleborus-Ceratostomella* at Hacienda, Clementina by painting the trunks with fungicide-insecticide mixtures were unsuccessful and costly, as the mixture was effective for only one week. Applications of insecticides from the air once per month, at the time when the *Xyleborus* insects emerged from their galleries, were more successful.

Applications of copper fungicides have increased yields, eliminated epiphytes (mosses, lichens), and reduced infection by *Colletotrichum, Marasmius perniciosus and Monilia roveri.*

K. E. Wallenius.
Septima Conferencia Interamericana de Cacao.
Palmira - Colombia, 1958 p. 270-273.

SOUTH PACIFIC

Mosquito Control: An experiment in biological control of mosquitoes by use of the fungus *Coclomonyces stegomyiae* on *A.polynesiensis* was sponsored by WHO in the Tokelau Islands. Dr. Marshall Laird and Dr. Colless are responsible for the work which was initiated in October, 1958 and results are awaited.

Dr. M. O. T. Iyengar, the South Pacific Commission's Mosquito Control Officer travelled widely over the eastern end of the area during the period under review and stopped in Nadi for brief discussions with the Inspector-General in May, 1959.

(South Pacific Health Service, Inspector-General's Report 1958-59.) Suva, Fiji.

(1) Food Losses in Field and Store

134th. meeting of the Nutrition Society, at Rothamsted, July, 1961.

The following are some notes, taken by kind permission of the editor, from the Proceedings of the Nutrition Society Vol. 20 No. 1.

Mr. M. S. Way started his interesting paper with a quotation from Curtis's "Farm Insects" (1859) which is worth reproducing - '.. animals which annually consume an amount of produce that sets calculation at defiance; and, indeed, if an approximation could be made to the quantity thus destroyed, the world would remain sceptical of the results obtained, considering it too marvellous to be received as truth'. This is of interest because it is only now, a hundred years later, that any large section of the public has become aware of the magnitude of the loss of production from pests and diseases of crops and from animals. Crop losses by pests were estimated at over £100 million annually in the early 1950's which brings home the magnitude of the losses implicit in the view that insects are man's greatest competitor for the earth's food resources.

Measurement of loss is difficult and shows much variation, due to climate, spacing, date of sowing and pest incidence; for instance the loss of beans, caused by *Aphis fabae* over a period of nine years at Rothamsted varied from 1.8 to 18.7 cwt. per acre, a range which makes nonsense of an "average" figure. Over thirteen years the loss of sugar yield from beet crops caused by virus yellows varied from 1.5% to 19.6% a range greater than the figure quoted above.

Strickland's detailed assessment (1959) of Brussels sprouts losses caused by *Brevicoryne brassicae*, 1946-55 showed a range of lost acres from 3.5% to 11.4% (duly subtracting and adding the standard errors) with a mean of 7.5% ± 2.4. From an annual total of 46,000 acres the equivalent of 7,500 acres, costing about £860,000 would have been lost with no aphid control, but the loss might still have been 4,500 acres even with standard control measures, which, including cost of control, would be about £700,000. This means that the efficiency of chemicals in preventing crop losses should be examined.

In some industries, such as the sugar-beet one in Britain, the unnecessary use of insecticides is prevented by an efficient advisory service but such is not the case with most other crops. For instance soil insecticide applied to 16% of the potato acreage only reduced wireworm damage by half and was only really justified on a few fields with high wireworm populations. In most cases the increased yield obtained from treatment barely paid for the cost of application, let alone the chemical.

Some crop areas treated with insecticides in England and Wales are:-

	Potatoes	Brussels Sprouts	Sugar Beet
1955	14%	22%	-
1957	-	74%	20%
1959	26%	-	95%

Mr. G. V. H. Herford's paper draws attention to the scale on which foodstuffs may be damaged by insects in storage. For instance FAO in 1946 estimated a conservative annual loss of 5% but a U.N. working party in 1950 showed an annual average loss by six Latin American countries of 35% of cereals and pulses. In the U.S.A. the loss in the Great Plains cereal zone, is 10% per season and in the southern states can be 9% of weight per month. In the Belgian Congo weight loss per year of storage was:- sorghum 50%, beans 20% and groundnuts 15% and in Sierra Leone par-boiled paddy lost 25%. This is the apparent loss and takes no account of the weight of insects and grass left in the food. Thus in the Sierra Leone experiment noted above the apparent loss was 25.5% but after sieving the figure rose to 41%. With maize attacked by *Trogoderma granarium* an apparent loss of 7% was doubled after sieving.

The awareness of these losses is growing and work is being done on means of prevention.

Mr. E. C. Large discussed losses in potatoes. The cost of using virus-free seed is some £3 million per year in a crop worth about £40 million. Potato blight, contrary to popular belief, has a stabilizing affect on yield, as in a wet year blight incidence is severe but crop is heavy and in a dry year there is little blight but the crop is low. Over ten years (1947-57) average loss, loss in a "blight" year and loss in non-blight year were all 0.3 ton per acre.

(2) GSA Buys DDT: The General Services Administration last month purchased 26 million pounds of DDT, 75% wettable grade, at an average price of 21.81 cents a pound. The insecticide is for use in the anti-malarial programme of the World Health Organization.

Contracts were awarded to four suppliers for the entire amount. The successful bidders were: International division of Allied Chemical Corp., New York, 3.6 million pounds at prices ranging from 21.9 cents a pound to 22.1 cents a pound; Lebanon Chemical Corporation, Lebanon Pa., 4 million pounds priced at 22 and 22.2 cents a pound; Montrose Chemical Corp., Newark, N.J., 8,150,000 pounds for 21.37 and 22.23 cents a pound; and Olin Mathieson Chemical Corp., Baltimore, 10,250,000 pounds for a low price of 20.99 cents a pound and a high of 21.10 cents a pound.

(21.81 cents per lb is equal to £156 per short ton). Agricultural Chemicals, Feb., 1961. p.87.

(3) Production of Pest Control Chemicals: The Census of production for 1958 has more interesting facts on the production of pest control chemicals. The report compares 1954 with 1958 and below the 1958 figures are given with the 1954 figures in brackets.

There are 49(42) establishments engaged in the trade; sales were £18.8 million (£15.3m) plus £2.4 million of merchanted goods and canteen takings. The establishments purchased materials worth £11.6 million (£7.9m.) and reduced their stocks by £0.17 million (£0.14m.) during the year. The industry's net output was £8.5 million (£5.5m.). The average number of workers (including working proprietors) was 5,602 (5,159) and the wages and salaries per head per year were, operatives £434 (£354), other employees £717 (£575).

The capital expenditure during the year was, Buildings, £0.17 million (£0.06), plant £0.21 million (£0.27) and vehicles £0.15 million (£0.06m).

(The Report on the Census of Production for 1958, Part 26 Fertilizers and Chemicals for Pest Control. H.M. Stationery Office.)

(4) PESTICIDES IN THE U.S.A.

For the crop ending 30th September, 1959 the following information is abstracted from "Pesticide Situation."

	1957/8			1958/9		
	Production Short tons	Domestic Consumption short tons	Average Price per short ton	Production Short tons	Domestic Consumption short tons	Average Price per short ton
			£			£
Toxaphene			157			157
Aldrin, chlordane heptachlor, toxaphene	49,140	39,417		43,438	36,665	
BHC, as Gamma	3,250	2,750		2,598	2,138	
Calcium arsenate	5,266	4,500	66	n.a.	n.a.	65
Copper sulphate	48,596	37,529	79	40,292	42,115	87
2,4-D acid	15,472	10,650	286	14,638	17,051	286
" ester	10,969			15,597		
" salts	1,482					
DDT	72,164	33,350	156	78,369	39,341	164
Lead arsenate	7,469	n.a.	195	n.a.		211
Methyl bromide	5,112			n.a.		
Methyl parathion	2,509			n.a.		
Ethyl parathion	2,719		907	m.a.		600
Pentachlorphenol	17,588			n.a.		
Phenyl mercuric acetate	528			n.a.		
Sodium chlorate	67,249			87,665		
2,4, 5-T acid	1,839		843	2,782	2,754	843
2,4, 5-T acid esters	2,665			n.a.		
Ziram	589			n.a.		
Aldrin			664			682
Chlordane			464			464
Cube		4,324	193			175
Dieldrin			1,301			1,321
Lindane			2,077			1,714
Endrin			2,539			2,418
Malathion			639			636
Pyrethrum		3,900	454			491

n.a. = not available

Both the production and consumption of chlorinated insecticides declined (19% and 7%). Whilst prices of lindane and endrine dropped, the former considerably, aldrin and dieldrin rose and toxaphene and chlordane remained the same. DDT production fell and consumption and price rose. The parathion price fell considerably.

(U.S. Dept. Agric. Commodity Stabilization Service: The Pesticide Situation for 1959-1960.)

(5) **Power Knapsack Sprayers:** Increasing interest is being taken in Power Knapsack Sprayers and PANS has collected together specifications from a number of machines on the market in Britain. These are set out in the table on the following page. It is hoped in due course to examine these machines and report on the specifications and performance.

Manufacturer	F. Allman & Co.	Cooper, Pegler	Dorman Sprayer Co.	Drake & Fletcher
Name of Sprayer	Mistblower	Hurricane	Ospray Ace	Mamba
Weight: unloaded	26 lb.	37 lb.	35 lb.	43 lb.
Capacity: Spray tank	2.3 gal.	2.25 gal.	2.25 gal.	2 gal.
Fuel tank	1.75 pints	3.5 pints		
Engine	2 stroke 26 ccs	Sacks 2 stroke Recoil starter 50ccs	2 stroke	2 stroke 75 ccs
Brake H.P. at revs.		1.6 H.P. at 5,200 r.p.m.	3 H.P. at 4,000 r.p.m.	
Fan Capacity	154 cu.ft./min at 5,900 r.p.m.	185 cu.ft/min at 102 m.p.h.	not specified	not specified
Air stream speed	227 m.p.h.	102 m.p.h.	267 m.p.h.	
Delivery				
Full nozzle opening	0.82 pints per min	4.8 pints per min		
¾ " "	0.58 " " "	3.2 " " "		
½ " "	0.16 " " "	2.4 " " "		
¼ " "				
Shipping dimensions	Cardboard container 24" x 18" x 14", gr.wt.32lb.	case 31" x 21" x 16", gr.wt. 79lb.		
Retail Home price	Mistblower £62 10s. 0d. Duster £67 10s. 0d. Duster attachment for mistblower £8 10s. 9d.	"Hurricane" £64 14s. 6d. Powder conversion Unit £8 14s. 6d.	£78 10s. 0d.	£65
Remarks	A metal dust holder can also be fitted	Quickly converted to Powder duster. Available extras Double row nozzle Flame lance and nozzle	Can also be used for dust and as flame gun	Can also be used for dust

Manufacturer	K. E. F.	Kestrel Engineering Co.	Kestrel Engineering Co.	Micron Sprayers Ltd.
Name of Sprayer	Motoblo 60	Minnipak	Powapak	Birfield Micronette
Weight: unloaded	27½ lb.	26 lb.	33 lb.	32 lb.
Capacity: Spray tank	2.2 gal.	2.2 gal.	2.2 gal.	1,2 or 5 gal.
Fuel tank	5 pints	2 pints		2 pints
Engine Self winding starter coil	2 stroke 60 ccs self winding starter coil	2 stroke JLO.L26 Self winding starter coil	2 stroke JLO self winding starter coil	2 stroke 34 ccs
Brake H.P. at revs.	3 H.P. at 6,000 r.p.m.	0.85 at 5 to 6,000 r.p.m.	1.8 H.P.	0.67 at 5,000 r.p.m.
Fan Capacity	500 cu.ft. per min	not specified	484 cu.ft. per min	
Air stream speed	240 m.p.h.	201 m.p.h.	245 m.p.h.	45 m.p.h.
Delivery and full nozzle opening	8 pints per min	0.1 pints per min	0.1 pints per min	1.6 pints per min
¾ " "	4 " " "	0.083 " " "	0.83 " " "	0.6 " " "
½ " "	2 " " "	.067 " " "	0.067 " " "	0.4 " " "
¼ " "				
Shipping Dimensions	5 in cardboard carton 60" x 30" x 24" Gr. Wt. 20cwt.2qr.18lb.	6 per crate 45" x 44" x 30" Gr.wt.2cwt.3qr.21b.	6 per crate 50" x 44" x 30" Gr.wt.3cwt.1qr.21b.	6 per crate 46" x 43" x 26" Gr.wt.3cwt.0qr.21lb.
Retail Home Price	Mist sprayer £59 10s. 0d. Duster attachment £6 0s.0d. Flame " £5 10s.0d.	£48 15s. 0d. f.o.b.	£52 10s.0d. f.o.b.	£54
Remarks	Slight head of pressure in tank. Can be used as duster and flame gun	Can be used as duster and flame gun Long range wide angle nozzles available. Liquid feed pressurised Rubber vibration dampers fitted.	) ditto.	

Manufacturer	Motan Uberlingron Bodense	W. Weeks & Son Ltd.
Name of Sprayer	Fontan R 5	Weeks
Weight, unloaded	37 lbs.	25½ lbs.
Capacity		
Spray tank	2 gal.	1.65 gal.
Fuel "	1.75 pints	1.75 pints
Engine	2 stroke JLO 75 ccs	2 stroke 26 ccs.
Brake H.P. at revs.	2.5 H.P. at 5,300 r.p.m.	0.82 H.P. at 6,550 r.p.m.
Fan Capacity	not available	not available
Air stream speed	190 m.p.h.	188 m.p.h.
Delivery		
Full nozzle opening	4 pints per min	Adjustable
¾ " "	2.2 " " "	
½ " "	1 " " "	
¼ " "	0.53 " " "	
Shipping Dimensions	23" x 28" x 21" Gross Wt. 57 lbs.	27" x 18" x 15" Gross Wt. 39 lbs.
Retail Home Price	£78 12s. 3d. f.o.b. Hamburg £68 15s. 0d.	Combined misting and dusting £82 10s. 0d.
Remarks	Machine will provide floating mists and graduated residuals	Can be fitted with a dust hopper

(6) The Coffee Berry Borer. (A Broca Dos Fruitos Do Cofe. Stephanoderes Hampei, Ferr.)

The coffee berry borer causes considerable losses in Angola especially when, as in the 1959-60 season, the flowering period is lengthy. Even in normal years at heights of up to 600 metres (say 2,000 ft) berries show an attack of from 10 to 20%. Losses drop off with altitude and over 1,000 metres (say 3,300 ft) almost disappear. Angola's losses due to this pest are more than 5% of production. The pest has no native host.

Control measures are:-

(i) A close season by carefully picking all fruit at certain times.

(ii) Insecticides: BHC, lindane, endrin and thiodan. Endrin is used at the rate of 600 gms per hectare. Thiodan is more economical. 3 litres of endrin liquid (19.5% a.i.) or 1.7 litres of thiodan liquid (35% a.i.) are mixed with 100 litres of water with 50cc of a sticker such as Adsol. The material is applied by knapsack mistblowers each of which can treat 2 to 3 hectares a day and the farmer should have enough machines to be able to give a treatment all round every 3 or 4 weeks.

A. da Fonseca Ferrao. Gazeta Agricola de Angola, Dec. 1960, 6, (5), 294-6.

BPS 50

W. J. Bush & Co. Ltd., Ash Grove, Hackney, London, E.8.

New pyrethrum synergist developed conjointly by Bush and the British Petroleum Co. Ltd., BPS 50 is described as a specially formulated mixture of aryl alkylketones and aryl alkanes with freedom from toxicity and taint.

Properties: Colourless, mobile liquid with a faint odour. Freely miscible with all hydrocarbon solvents commonly employed as insecticide carriers, petroleum ether, white spirit, kerosene, technical white oil, xylene and ethyl alcohol. BPS 50 is itself very stable and does not have any adverse effects on the stability of pyrethrins or, for that matter of chlorinated hydrocarbon insecticides where these occur in a formulation. BPS 50 is compatible with BHC, DDT, or methoxychlor and itself remains unaffected by liquified gases such as the fluorinated hydrocarbons and other aerosol propellants.

Density at 25°C., 1.005. Flash Point (Closed Cup), 118.3°C.

Setting Point, 23°- 24°C (tends to supercool).

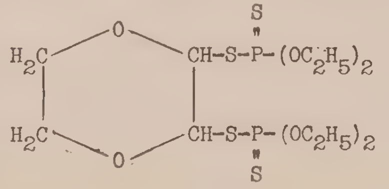
Toxicology: The acute oral toxicity of BPS 50 to rats lies between 2.5 ml./kg and 2.75 ml./kg. It may therefore be considered as a substance of low toxicity. BPS 50 presents no hazards in handling, but in view of its setting point (23°C - 24°C), some care will need to be exercised in its storage.

Activity: As is usual with pyrethrum synergists, the factor of synergism varies considerably with the species of insect, the ratio of synergist to pyrethrins and the method of applying the insecticide. With houseflies *Musca domestica* L. a knock-down equivalent to that given by 0.1% w/v pyrethrins can be obtained with 0.04% w/v pyrethrins synergised with 0.28% w/v BPS 50. In this case the ratio of synergist to pyrethrins is 7:1 and the factor of synergism for knockdown is 2.5.

DELNAV

Hercules Powder Co., Wilmington, Delaware, U.S.A.
Brochure NS-261.

Delnav is the technical grade of the chemical 2,3-p-dioxanedithiol S,S-bis (0,0-diethylphosphorodithioate). It is a non-volatile, non-inflammable, very stable, dark amber liquid. Its density is 1.257 at 26°C and its viscosity 117 centipoises at 25°C. It contains 68-70% of *cis* and *trans* forms of 2,3-p-dioxanedithiol S,S-bis(0,0-diethylphosphorodithioate). Delnav is insoluble in water. In general, it is soluble in aromatic hydrocarbons, alcohols, ethers, esters, and ketones. It is soluble in all proportions in ethanol, acetone, benzene, and xylene. It has limited solubility, less than 1%, in kerosene and hexane. The product is very stable on prolonged storage and in water dispersions. It is hydrolysed by alkali and will decompose if exposed to iron or tin surfaces. It is also subject to catalytic decomposition when mixed with certain carriers at elevated temperature.



Delnav

Activity: The chemical is active against mites and ticks infesting plants and animals and against many insect pests. It is, however, harmless to bees. No phytotoxic effect has been observed on any crop treated in the U.S.A.

Mode of Action: Delnav may be classified as a nerve poison, producing and/or inducing cholinesterase inhibition. Like other synthetic organo-phosphorus compounds, its action seems to block the nerve impulse at the synapses of afferent nerves. This interference with neurotransmission may be responsible for the main symptoms in poisoned insects, i.e. irritability followed by excitation, tremors, and eventually paralysis and death. The cuticle of insects or mites does not interpose a barrier to the entry of the chemical into their system. Thus, Delnav is considered a contact pesticide. It will also make its way to the nerve system of a given insect or mite when ingested. In this way it becomes also a stomach pesticide.

Various types of tests have been made to detect possible systemic action of the compound. Excised stem tests, leaf expansion tests, seed treatment and radio-active tests all indicate negative systemic action. When applied as spray, however, it has definitely shown a high degree of penetration in locus. When applied to one surface of a leaf, it enters through the epidermal and parenchimal tissues of the leaf, poisoning sucking insects or mites feeding on the other side of the same leaf. This penetration is increased when certain surfactants are added.

Toxicology: The acute oral toxicity of Delnav to male albino mice for LD_{50} has been determined as 176 mg/kg. To male albino rats the LD_{50} was found to be 50 mg/kg. The acute dermal toxicity of Delnav to albino rabbits for LD_{50} was 0.085 ml./kg or 106 mg/kg. In subacute studies, 10 p.p.m. of Delnav in the daily diet of rats for 90 days produced slight inhibition of plasma and red blood cell cholinesterase, whereas 3 p.p.m. produced no inhibition.

Subacute feedings of Delnav to dogs up to a 3-month period gave findings similar to those obtained with rats. Daily administration of 0.25 mg/kg (equivalent to 10 p.p.m. in the total diet) produced slight blood cholinesterase inhibition, whereas 0.075 mg/kg (equivalent to 3 p.p.m. in the total diet) produced no inhibition. The cholinesterase inhibition produced by Delnav in both rats and dogs was rapidly reversed when Delnav administration was discontinued. Administration of much higher dosages of Delnav to these animals revealed no toxic properties unrelated to cholinesterase inhibition.

Experimental feeding of Delnav to humans daily for 60 days has shown that 4 p.p.m. of residual Delnav even if present in the entire diet produces no blood cholinesterase inhibition. Unlike certain other organo-phosphorus compounds, there is very little difference between sexes in susceptibility to Delnav.

Potentiation: Delnav does not seem to potentiate other anti-cholinesterase pesticides. Potentiation studies conducted with Delnav and 15 other anti-cholinesterase materials showed that the administration of equitoxic mixtures of Delnav plus each of the other compounds included in the study (parathion, methyl parathion, malathion, EPN, "Systox", "Guthion", diazinon, "Dipterex", "Phosdrin", "Tetram", "Di-syston", "Trithion", OMPA, "Sevin" and "Ethion") resulted in LD_{50} values which approached the values expected on the basis of additive toxic effects. In no case was the observed value sufficiently different from the expected value to indicate significant potentiation of toxicity.

Residues: Field tests under widely varying climatic conditions in both North and South America have demonstrated a useful miticidal activity for periods of several weeks to several months after application. Residues at time of harvest are influenced by application rates, frequency of application, and type of crop. On mature citrus, residue half-lives in the range of 60 to 90 days have been observed, while residues on apples have shown half-lives of about 30 days.

Application: The dosage rate is normally between ½ and 1 lb per acre on vegetable, fruit and field crops. Lower concentrations are recommended for the control of ectoparasites.

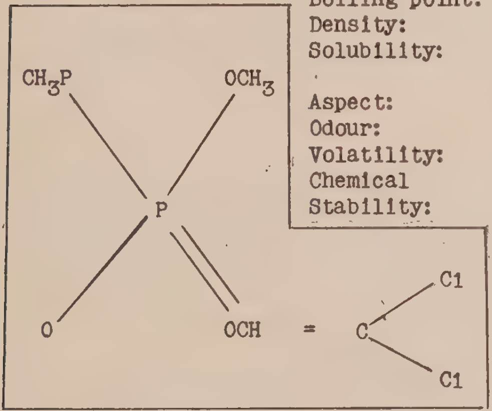
Nomenclature: Other names which have appeared in the literature for this material during its research and development stages include AC528, Hercules 528, and Navadel. These have since been superseded by the name Delnav.

Handling Precautions: Delnav is relatively toxic to humans. The usual handling precautions must be strictly observed.

THE INSECTICIDE DDVP

Ciba Ltd., Basle, Switzerland

The insecticide DDVP (O:O-dimethyl-2:2-dichlorovinyl phosphate) was first found by chemists of Ciba Ltd., and later by American and German research workers,



Properties:

Boiling point:	$84^{\circ}C$ at 1 mm Hg pressure.
Density:	1.415 at $25^{\circ}C$.
Solubility:	Miscible with nearly all solvents; soluble in water to nearly 1%, in kerosene about 2-3%.
Aspect:	transparent, mobile liquid.
Odour:	pleasant, somewhat aromatic.
Volatility:	vapour pressure at $20^{\circ}C.$, 0.15 mm Hg.
Chemical Stability:	DDVP is slowly decomposed hydrolytically in the presence of water. In an alkaline medium, decomposition takes place extremely rapidly, in acid solution somewhat more slowly. Decomposition leads to dimethyl phosphate and dichloracetaldehyde, which disintegrates further under alkaline conditions.

Activity: DDVP is considered to be a highly active contact insecticide with a pronounced fumigating effect. On account of its volatility its chief use is in controlling insects and mites in greenhouses, closed storerooms and living rooms. It would also appear to be suitable as an agent for controlling ectoparasites on warm blooded animals. An attempt was made to demonstrate the contact-insecticidal effect of DDVP in comparison with parathion, diazinon, aldrin, lindane and dichloro-diphenyl trichloroethane when applied topically, with the result that DDVP was shown to be superior to all the above active substances. Its application in the form of aerosol is particularly interesting on account of the low threshold concentration and the amazing rapidity of effectiveness. The analysis of investigations on toxicity made by the firm and outside, shows that the practical use of DDVP is possible without any particular risks.

Toxicology: The LD_{50} per os in male rats is 70-80 mg/kg, as compared with 7-13 mg/kg for parathion. The corresponding values in mice show less pronounced differences.

In the case of sublethal doses the experimental animals recover extremely rapidly, from which it may be concluded that the speed of degradation of DDVP in the organism of warm-blooded animals is high. Van Asperen points out that the cholinesterase inhibition caused by DDVP in warm-blooded animals is in some cases reversible, whereas in insects it is irreversible. The value found by Klotzsche for percutaneous toxicity, 900 mg/kg, can be regarded as very favourable.

In view of the application of DDVP in aerosols, inhalation toxicity is especially interesting. Investigations in this respect by our firm with rats have shown that with an effective concentration of about 22 mg/m^3 of air and an exposure of 2½ hours only slight transient cholinergic symptoms occur during exposure. These test-conditions correspond to a fourfold (in greenhouses) to twentyfold (in living rooms) overdosage as compared with the concentrations required for practical application.

In the investigations made by Tracy et al, mice, rats, guinea pigs and rabbits were exposed for 24 hrs. to the vapours of prepared, varying amounts of DDVP. It goes without saying that only a small fraction of these amounts, at a maximum 1000 g/m^3 of air, evaporated and had any effect in the gas phase. Absolutely no toxic symptoms could be observed in the experimental animals during exposure and subsequent 21 days. Exposure of rats for a total period of 6 weeks and an intermittent exposure time of a total of 95 hrs. a week produced a slight transient cholinesterase inhibition. The effective DDVP concentration measured by infrared analysis was between 0.4 and 1.1 mg/m^3, which amount produced an adequate insecticidal effect.

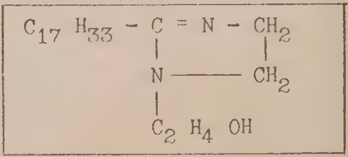
(On the Insecticidal Effect of DDVP (0:0-dimethyl 2:2-dichlorovinyl phosphate, Ciba Ltd., Basle Pest-Control Department.)

GEMEX 220

Union Carbide

Of interest to the research worker and industrialist alike, surface active agents owe their activity to the long-chain alkyl or aryl-alkyl molecules containing polar groups. Familiar soaps and detergents are often derived from carboxylic, sulphonic or similar acids - the organic group being activated by a negative charge. Sometimes known as 'reversed soaps', cationic surface active agents are basic molecules, and therefore active in acids or other protogenic solvents.

Among the most interesting of the cationic surface active agents is Gemex 220, chemically 1-hydroxyethyl-2-heptadecenyl imidazoline.



It is an oil-soluble amber coloured liquid, which can be dissolved in polar solvents by treatment with acids, acid salts or esters.

The outstanding property of this compound and its salts, is an ability to emulsify oils, such as diesel, mineral and vegetable oils.

HEPTACHLOR

Velsicol Chemical Corporation

Leaflets describing the following application have been received:

Alfalfa weevil: Application of heptachlor after the last cutting of alfalfa kills alfalfa weevil adults which prevents egg laying. The following spring there are no larvae present to cause damage. The granular forms are most suitable. Apply heptachlor 2½% granules at 30 to 40 lb/ac or 5% granules at 15 - 20 lb/ac. Heptachlor/fertilizer mixtures are also available.

Corn Cutworms: For control of soil insects on corn, including cutworms, heptachlor is stated to give an average yield increase of over 2 bushels per acre more than any other soil insecticide.

Row treatment with heptachlor granules is the most economical way to control soil insects on corn and many other crops. Applicators are available that can be attached to any planter or lister.

It is recommended to apply 20% or 25% granules at dosages ranging between 1 and 2lb/a.i. per acre.

Seed Treatment: Heptachlor can be mixed dry with the seed in the grain drill or planter at planting time, or added to the seed and thoroughly mixed in a revolving or drum type treater prior to planting. Whichever way you do it, formulations of wettable powders (25% or 50%) alone, or in combination with a fungicide can be used. The 50% formulation is especially formulated for commercial seed treatment and can be applied as a dust or slurry.

For the control of white grubs, wireworms, and false wireworms, that damage wheat seed, mix 8lbs heptachlor 25% wettable powder or 4lbs. of 50% w.p. with the wheat seed used to plant one acre. Plant the combination with a grain drill.

INSECT REPELLENT MULTIWALL PAPER SACKS

Purnell Group Research Division, Cumberland Paper Co. Ltd., Cleator Moor, Cumberland.

The fact that, under temperate climatical conditions, the infestation of stored products in Multiwall sacks is mostly by invasion through the weakness of the structure, led to the idea of developing an insect-proof closure for Multiwall sacks by using a treated creped Kraft tape for bottom and top closures, stitched with treated thread. (Patent applied for).

To test its effectiveness artificial infestation tests on Multiwall sacks filled with (1) pigmeal, (2) flour and sealed with "Pybuthrin" treated creped Kraft tape and cotton thread were set up at the Cooper Technical Bureau. Tests were carried out at 80°F., 60% R.H. The creped Kraft tape was treated on the inside with 10 mg pyrethrins/100 mg piperonyl butoxide per sq.ft.

After 11 months the sealing strips were reported to have given complete protection against a range of stored product pests, including grain weevils, *(Calandra granaria)*, flour beetles *(Tribolium* spp.), flour moths and cacao moths *(Ephestia* spp.), saw toothed grain beetles *(Oryzaephilus surinamensis)*.

Under most severe tropical conditions it is considered that Multiwall sacks might be infested by penetration of boring insects through the structure of the paper. Accordingly, insect repellent tape closures and treated thread alone might not be sufficient for full protection. For such extreme conditions there have been developed Multiwall sacks with the second layer from the outside made from treated sack kraft. These in combination with the treated tape and thread, should give the necessary protection. Tropical field tests for this type of insect repellent Multiwall sack are now being carried out. By using wax coating for "Pybuthrin" treatment, these treated papers are water repellent, with the addition of a moisture/vapour barrier.

KESTREL "MINIPAK"

Kestrel Engineering Co. Ltd., 26 Holborn Viaduct, London, E.C.1.

The standard Minipak is fitted as a mist sprayer. The unit is powdered by a 26 c.c. JLO engine, which is mounted to the fan casing. The fan is driven directly from the engine shaft. The fan casing is mounted on to the frame by rubber vibration dampeners.

The non-corrodible plastic tank which holds just over 2 gal. of liquid is pressurised by a bleed off, from the fan. Spray fluid is positively fed into the nozzle where it is drawn off and atomised by the air stream, the air acting as a carrier and thus eliminating the need for large quantities of water as a diluent. Two types of nozzle are available and a graduated tap gives immediate quantitative control.

Use as duster: The dust hopper is interchangeable with the liquid container, being secured by two easily manipulated spring clips. The fan bleed off outlet is closed with a plastic cap. Dust feed is by air agitation and is without any mechanical parts to cause blockage, bridging or compaction of dust. The air control in the hopper also serves to keep the dust in suspension to disperse any conglomerations. Finger tip control of dust output is provided.

Use as flame thrower: The special flame thrower attachment is used with the mist spraying unit replacing the ordinary nozzle. The liquid container is filled with fuel and the atomised oil directed to a burning piece of paper to light. The length of flame obtained may be controlled; one tank-full will give one hour's burning. The air blast prevents the flame tube from overheating and the attachment can be operated without any fear of burning or even discomfort.

Specification

DIMENSIONS	Height: 26" Width: 17" Depth: 12"
WEIGHT	Mist spraying unit: 28 lbs. Hopper: 10 lbs.
ENGINE	JLO L26. Fitted with self winding starter coil (automatically returned by spring). Rated capacity: 0.85 h.p. at 5-6,000 r.p.m. Fuel consumption: ½-¾ pint per hour of Petrol/Oil mixture-25: 1.
CAPACITY	Liquid container: 2.2 gals. Dust hopper: 610 cu.ins.
PERFORMANCE	Air speed up to 295 ft. per second
RANGE	Vertical: 20 ft. Horizontal: 25-30 ft.
OUTPUT	Liquid: 0-6 pints per hour. Dust: 0-4½ pounds per minute.
NOZZLES	Long range nozzle for distant work. Wide range nozzle for close work. Flame thrower nozzle.

Note. The Kestrel 'Powapak' is also available. This is similar to the 'Minipak' but fitted with a more powerful engine. It enables a wider range of nozzles to be used.

PP 175 (MENAZON) SUPPLEMENTARY INFORMATION

Plant Protection Ltd. Fernhurst, Nr. Haslemere, Surrey

Nomenclature: The British Standards Institution have accepted the coined common name menazon, for the chemical previously referred to as PP.175.

Formulation: Work has been done on the preparation of dusts and of dry powder formulations which would be suitable as seed dressings. Granules for broadcast and foliar applications appear to be relatively easy to manufacture.

A new technique has been evolved for the preparation of water dispersible liquid formulations of menazon and the development of a satisfactory product is well advanced.

It should be noted that where formulations are used at high dilution, the menazon will be in solution - its solubility in water being about 0.1%.

Toxicology: The toxicity of this compound to mammals is low. Revised figure for acute oral LD_{50} to female rats is 1950 mg/kg. Intraperitoneal single dose LD_{50} (female rats) is 615 mg/kg. No local irritant effects were produced by applying a 20% solution in polyethylene glycol 300 to dehaired dorsal skin in 6 rats.

No local or systemic toxic signs have been observed in rabbits after the application of doses of the order of 500-800 mg/kg. to dehaired skin for 24 hrs.

Residues: All available evidence suggests that menazon is broken down only in plants. Studies have been restricted to broad bean, French bean, sugar beet and tomato plants using various methods of uptake. Radioactive menazon has been extensively used in this work.

From experiments in which radioactive menazon was administered to broad bean plants through a cut tap root, the half-life of menazon taken up by the plant and calculated as total radio-activity was about 28 days. In the field the loss of menazon is more rapid because of removal of surface deposits by rain and general weathering.

At least four radioactive metabolites of menazon have been detected in very small amounts in plants treated with the radioactive aphicide and left for several weeks.

Analysis: Menazon is broken down by acid digestion to organic phosphate which is estimated, with a slight modification, by the colorometric method described by Chen, Toribara and Warner, Anal. Chem. 1956, *28*, 1756. The limit of detection of the method is in the order of 0.05 p.p.m.

Applications: Menazon may be especially useful

(a) where biological control is important in limiting aphid populations

(b) where aphids are vectors of virus diseases

(c) where pollinating insects are essential for maximum yields

(d) where application methods demand a material of low toxicity to man.

Menazon is primarily an aphicide but tests on other pests including mites, leaf and frog hoppers and spring tails are worth while.

Menazon sprays should be tried on all crops where aphids are of economic importance. High volume sprays should be applied at concentrations of 100 - 300 p.p.m. Low volume sprays should apply 3 - 6 oz. per acre on field crops such as sugar beet and potatoes and 6 - 12 oz. per acre on fruit.

Seed dressing should be tried on crops where aphids are important in the early stages of growth, either by reason of mechanical damage or virus transmission. These will include sugar beet, cotton, alfalfa, beans, groundnuts, brassicae and cereals. Dosage rates will vary between 0.2 and 4% by weight, according to the seed and seedling rates but should aim to apply ¼ - 1 lb. menazon per acre on the seed. Where seeding rates are low as in sugar beet and brassicae, a sticker may have to be employed to achieve these dosages.

Seed potato tuber treatments have been very effective. A method that has been used successfully is to spray the seed potatoes before planting with a 2%-4% aqueous dispersion of the powder formulation to give ½ - 2 lb. menazon per acre at normal planting rates. Dips and dusts should also be tried.

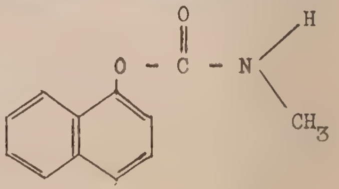
Granules applied to the soil before planting or sowing should be tried on crops such as potatoes and sugar beet. On sugar beet, pre-emergence and post-emergence applications are also worth investigation. Dosage rates should fall between ½ to 2 lb. menazon per acre.

Soil drenches should be tried on established crops such as hops at rates of ½ - 2 lb. menazon per acre and on seed beds of brassicae and tobacco where early virus infection is important, at rates up to 5 lb. menazon per acre.

SEVIN

Union Carbide International Company, 270 Park Avenue, New York, 17, U.S.A., U.K. address:
Union Carbide Ltd., 8 Grafton Street, W.1.

Revised particulars are contained in two brochures published by the manufacturer. Sevin is the technical grade (at least 95% pure of 1-naphthyl N-methylcarbamate. It is a crystalline solid, substantially odourless, stable to light and to heat up to 70°C. The compound is rapidly hydrolysed to alpha-naphthol in strong alkaline solutions (pH 10). It keeps well under prolonged storage. Its solubility in water is less than 0.01% (99 ppm.) Its per cent solubility in organic solvents is shown in the accompanying table.



Formulations: Emulsifiable concentrates are not being marketed for reasons of high cost and their lack of stability. Sprays are generally based on wettable powders, which include "Sevin" 50 W (for use in fruit and vegetable growing areas), "Sevin" sprayable (85% a.i., 2 micron particle size, used in cotton growing areas, suitable for aerial spraying) and "Sevin" 85 P (a microfine 85% powder specially formulated for the preparation of oil concentrate sprays). Dusts 5% and 10% are available. "Sevin" 5% granular on 15/30 mesh attapulgite has been successfully used in field

Percent Solubility of Sevin, Technical Grade, in Organic Solvents	
methylated naphthalenes	5
petroleum distillate	5
isopropanol	10
xylene	10
ethylene glycol	20
methylisobutyl ketone	20
petroleum ether	20
cyclohexanone	20-25
isophorone	20-25
acetone	20-30
dimethylformamide	30-40
mixed cresols	40-50

experiments and is available for experimental testing from the manufacturer.

Toxicology: The acute oral LD_{50} of "Sevin" to rats is given as 540 mg/kg. Comparisons with other pesticides are shown in the adjacent table. The figure given for single skin penetration LD_{50} in rats is 5000 mg/kg. Results of tests on dogs and rats indicate a low degree of chronicity, probably due to the rapid breakdown of "Sevin" in the body to non-insecticidal components. There was no effect on the health of dogs fed 400 ppm. in dry diet, 5 days a week for 1 year, or on rats fed a dosage of 200 ppm. for 2 years.

Acute Oral LD_{50} for Certain Pesticides
mg. toxicant/kg body wt in rats

Parathion	3	Lindane	125
Endrin	10	Diazinon	200
Phosdrin	13	DDT	250
Methyl parathion	15	Sevin	540
Guthion	15	Kelthane	575
Trithion	28	Malathion	1500
Toxaphene	69	Aramite	2000
Dieldrin	87	Methoxychlor	6000
Lead arsenate	100	Tedion	14700

Birds and Fish: White leghorn chicks have been treated with 0.5% dips and 5% dusts, and hens have consumed up to 3000 ppm. in feed for 8 days without symptoms of poisoning. Feeding studies with pheasants also indicate that birds are quite tolerant of "Sevin".

The toxicity of "Sevin" to fish has been evaluated in the laboratory with goldfish, fathead minnows and bluegills, and in the field with silversides, sheephead minnows, the mummichog killifish, fresh-water trout and salmon. The LD_{50} was from 10 to 400 times greater than that of DDT, most of these species being about 200 times less susceptible to "Sevin" under the conditions of the tests.

Phytotoxicity: "Sevin" has been used in conjunction with a wide variety of pesticides in laboratory and field tests without causing plant injury or loss of pesticidal activity. It is not compatible with alkaline materials, and should be applied cautiously in orchard spray oils.

Activity: The compound has shown activity on a wide range of insects as a contact and/or stomach poison with good residual properties. In many instances "Sevin" has proven effective against insects which have developed resistance to other commonly used pesticides. Insecticide treatments with wettable powder and dust formulations at rates of 0.5 to 2.0 pounds active ingredient per acre (0.5 to 2.0 kg per ha.) give efficient control of many major plant pests. It is being employed commercially on cotton, deciduous and small fruits, olives, citrus, cocoa, coffee, sun flower, pineapple, sorghum, rice, bananas, sugarcane, livestock, vegetable crops, and ornamentals; and against grasshoppers, locusts, leaf-cutting ants, and household pests. Promising leads in forest, rangeland, and forage insect control are being developed. "Sevin" is ineffective against most phytophagous mites. The compound exhibits a positive temperature-toxicity relationship.

Speed of Action: The amount of toxicant employed and the inherent susceptibility of the insect species are important in determining the speed of action of an insecticide. When optimum dosages are used or when highly susceptible insects are encountered, "Sevin" is very rapid in action, in many cases approaching the speed associated with the organic phosphates. Generally, however, "Sevin" shows approximately the same degree of initial activity as that of chlorinated hydrocarbons. Insect knockdown is only slightly faster than DDT and considerably slower than parathion in a number of tests.

Persistence: Weather conditions and the properties of the treated surfaces, as well as the factors mentioned above, affect duration of insecticidal residues. In rainbelt cotton, "Sevin" is often used at 5 to 7 day intervals, while much longer residual is common in irrigated areas. Most orchardists control the codling moth on a 10 to 14 day schedule, except in dry regions where 21 to 30 day application intervals are completely effective. In residual characterists, "Sevin" more closely parallels the chlorinated hydrocarbons than the organic phosphates. Moderate to highly effective residual activity has been demonstrated with "Sevin" from 5 to 35 days after a single treatment.

Synergism: The activity of "Sevin" can be synergized with methylendioxphenol compounds and others. A positive response has been obtained against bean aphid *(Aphis rumicis)*, house fly *(Musca domestica)*, and German cockroach *(Blatella germanica)* in laboratory tests employing piperonyl butoxide as a synergist for "Sevin" insecticide..

Public Health Uses: Experiments have shown that dips and sprays containing 0.05 to 0.2% actual "Sevin" will provide excellent control of ticks of the genera *Ambylomma*, *Boophilus*, and *Rhipicephalus*, with no detrimental effects on calves, cattle or goats. It is also effective against biting and sucking lice at these rates. As a residual control agent for horn fly, *Lyperosia irritans*, and stable fly, *Stomoxys calcitrans*, on dairy cattle, "Sevin" 0.5% sprays perform well for 5 to 7 days after treatment.

Cockroaches, *Blatta orientalis* and *Blatella germanica;* bedbugs, *Cimex lectularius*; chiggers, *Trombicula irritans;* earwigs, *Forficula* spp.; and body lice, *Pediculus vestimenti*, have been shown susceptible to the contact and residual action of "Sevin". It has failed to control adult house flies, *Musca domestica*, at concentrations employed with standard materials.

BANANAS Pest, Disease and Weed Control

Shell

This booklet summarises the information available on the use of Shell chemicals in banana plantings. This information is derived from various sources, from literature, from contact with research organisations and from Shell agronomists working in the field. The booklet is adroitly written and usefully illustrated. 117 literature references are given.

FARM CROP PROTECTION CHEMICALS HANDBOOK

May & Baker Ltd., Dagenham, Essex.
Handbook. 5th Edition 1961 pp.151. Many photographs, diagrams, tables.

The purpose of this new edition of the technical handbook is "not only to outline the significant contribution made by May & Baker Ltd. in the discovery and introduction of new products and the improvement of existing ones, but also to give the fullest possible information concerning the technique of crop protection with our products, so that the very best use can be made of them."

The handbook is well presented, informative and easy on the eye. Contents include an Introductory Section followed by Formulations, Spraying Techniques, Treatment of Individual Crops, Weeds, Grass Weed Control, Brushwood Control and Insecticides and Fungicides. It is complete with several pages of tabulated data on rates of application.

FRUIT GROWERS BOOKLET

Murphy Chemical Company Ltd., Wheatampstead, St. Albans, Herts. pp.124 with figures and tables.

In this 1961 edition, recommendations are revised to bring them up to date. The booklet is well set out and contains, as before, a large assortment of interesting data.

NURSERYMAN'S BOOKLET

Murphy Chemical Company Ltd., Wheathampstead, St. Albans, Herts. 1961, pp.132.

This 1961 edition of the Nurseryman's Booklet has been thoroughly revised and, where necessary recommendations have been altered in the light of recent research and experience.

Pests, diseases and other troubles are listed alphabetically under crop headings, and control measures are given according to their method of application. Where several products occur under one heading, they are, as far as possible, in order of preference.

Since the publication of the last edition in 1959 several new products have been added including dusts based on malathion and thiram, nicotine shreds, atomising concentrates containing "Kelthane" and "Karathane" as the active ingredients, and "Guesatop" (50% simazine).

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THE INSECT PESTS OF GRAMINACEOUS CROPS IN EAST AFRICA

I. W. B. NYE. Colonial Research Study No. 31, Report of a survey carried out between March 1956 and April, 1958.

A report is given of the insect pests of graminaceous crops in Kenya, Tanganyika and Uganda carried out in 1956-1958. The principal pests of maize, sorghum, millet and rice are the stalk boring caterpillars including the Noctuids, *Busseola fusca* (Fuller), *B. phaia phaia* Bowden, *B. phaia segeta* Bowden (stat. nov.), *Sesamia calamistis* Hmps., *S. poephaga* Tams and Bowden *S. nonagrioides botanephaga* Tams and Bowden (stat. nov.), *S. pennisetti* Tams and Bowden, and *S. cretica* Led., and the Pyralids, *Chilo zonellus* (Swinh.), *Chilotraea argyrolepia* Hmps. *Eldana saccharina* Wlk. and *Maliarpha separatella* Rag. A review, incorporating the results of the survey with the existing published knowledge of the distribution, life history, host plants and natural, cultural and chemical control methods of each of these species and subspecies, is given. Drawings of the male and female genitalia of ten species are provided as a means of identification.

Distribution maps show that the two most economically important species, *Busseola fusca* and *Chilo zonellus* are distributed by altitude, the former from 2,000 to over 9,000 ft. and the latter from 0-5,000 ft. The third most important species, *Sesamia calamistis*, occurs at all altitudes but particularly in damper localities and ricefields.

The populations of stem boring caterpillars per unit area within the wild species of host grasses were always found to be low in comparison with those in adjacent cultivated graminaceous crops, and extremely low when no cereals were growing in the proximity. The main source of infestation is from the larvae remaining in the residues of previous crops.

The larvae of *Busseola fusca* undergo a facultative diapause when the stems in which they are feeding become dry, but the larvae of *Chilo zonellus* do so only under very severe conditions. This is of importance when attempting chemical control as the onset of the rainy season terminates the diapause. In the case of the larvae of *B. fusca*, the pupation, emergence of the imago, and oviposition is then more or less synchronised over a large area. *C. zonellus* can, however, continue to breed during the dry season and consequently at the onset of the rains there are present, immature stages of all ages. These mature and oviposit over an extended period with the result that chemical protection of the new crop should be concomitantly prolonged.

The bionomics and literature of other species encountered during the survey are summarised under the following headings: shoot flies; root and shoot feeders; leaf and stalk feeders; and seed feeders.

Chemical Control: Economically successful control measures are possible in areas where *B. fusca* is the dominant pest if there is a reasonably well defined distribution of rainfall. The onset of the rains terminates the resting phase of the larvae, and the moths emerge more or less together over a wide area. There is a subsequent wave of oviposition which takes place over about three weeks. The larvae hatch from the eggs laid on the lower leaf sheaths which can be treated easily and with a minimum wastage of insecticide. Larvae remain feeding on the tender central leaves for several days, and only gradually penetrate down into the stalk and during this period are subject to the risk of encountering or ingesting any insecticide that may have been applied. Heavy rain, by washing insecticide further into the funnel, does not render it ineffective to the same extent as it would on other parts of the vegetation. In addition, the potential yield of the crop in these areas is high and the stalk borer is often the major hazard.

Very different considerations, however, affect the feasibility of using chemical control in the plateau areas. Here, in addition to *B. fusca*, *C. zonellus* is present. It has already been noted that this species can continue to breed during the dry season on sorghum tillers, and consequently, at the onset of the rains, immature stages of all ages can be found. They reach the adult stage over an extended period and consequently oviposition on the new crop is protracted, so that chemical protection has to be concomitantly prolonged. Eggs are usually laid on the underside of the leaves of maize and sorghum and the young larvae tend to bore into the midrib and migrate upwards through the leaf sheaths, keeping under cover to a greater extent than *B. fusca*. In addition to the greater difficulty in protecting a crop against *C. zonellus* is the fact that in areas where this species occurs the potential yield is often low, due to poor husbandry, poor soil and unreliable rainfall. When considered in relation to these factors as well as to the presence of other pests, stalk-borer is a hazard of only secondary importance.

Sesamia calamistis is even more difficult to control by chemical methods, since the larvae, when they hatch from the eggs, laid behind the lower leaf sheaths, bore straight into the stem.

OBSERVATIONS ON THE FEEDING BEHAVIOUR OF ANOPHELES GAMBIAE AND ITS EGRESS FROM EXPERIMENTAL HUTS TREATED WITH MALATHION AND BAYTEX

A. SMITH. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 284.

Author's Conclusion:

1. There is no evidence that these insecticides exert any irritation or depression of feeding activity on *A. gambiae*.

2. Egress from Magugu experimental huts into window traps is similar to that observed in experimental huts in other areas viz. Taveta and South Pare. This suggests that the behaviour of *A. gambiae* in the experimental huts at Magugu is not determined so much by the materials used in their construction as the general design of the present experimental hut.

3. The smaller numbers of *A.gambiae* caught in the treated than the untreated huts (see below) conform with previous findings (Miscellaneous Report No.283) which suggested that the smell of the insecticide possibly masked human odour, so that relatively few mosquitoes were attracted into the treated huts.

	Unfed	Fed	Gravid	Total	Unfed	Fed	Gravid	Total
	MALATHION (hut No. 15)						BAYTEX (hut No. 16)	
Window trap-Alive	15	10	7	32	18	17	23	58
Window trap-Dead	7	1	5	13	13	2	20	35
Hand catch	9	216	20	245	2	130	27	153
Floor Catch	1	15	1	17	0	0	0	0
Total	32	242	33	307	33	149	70	252
	UNTREATED (hut No. 1)						UNTREATED (hut No. 8)	
Window trap-Alive	131	39	82	252	147	49	75	271
Window trap-Dead	56	2	34	92	86	11	15	112
Hand catch	11	207	58	276	8	489	100	597
Floor Catch	0	0	0	0				
Total	198	248	174	620	241	549	190	980

Numbers of *A.gambiae* in Experimental hut catches.

Bio-assays

Bio-assays on the roofs, with W.H.O. plastic cones, and exposure times of two hours duration, suggested that the roof deposits might still be lethal to the naturally entering *A. gambiae* when delayed mortalities were taken into account. Results were as follows:-

Hut No.	Condition	No: *gambiae* tested	Percent. mortality
15	malathion	119	91
16	baytex	137	90
1 & 8	untreated	131	44

REPORT ON THE CESSNA 182 AIRCRAFT VR-TBW

R. F. HILL and D. R. JOHNSTONE. Colonial Pesticides Research Unit, Porton Down, Salisbury, England. Report No. 128, pp.12, refs, appendix and 7 figs.

Contents: Introduction. Description of the Aircraft. The Sorensen Sprayer. The Micronair Rotary Atomiser. Aircraft Performance Test. Functioning Trial and Spray Assessment. Discussion. Conclusions. Acknowledgements. References. Appendices. Figures.

The Authors report that a Cessna 182 aircraft has been modified to carry four Britten-Norman Micronair rotary atomisers and a Sorensen boom and nozzle spray system.

A spray assessment trial indicated that the rotary atomisers should be particularly suitable for spray work in which a volume median diameter of less than 100 microns is required.

More specifically, when spraying water at 8 g.p.m. with a windmill blade setting of 27½° and flying at 95 m.p.h., the v.m.d. of the spray produced was 93 microns. Spray cut off cleanly and no aircraft contamination was observed.

The authors compare their results with those obtained by Hill and Jarman (1956) using the original Britten-Norman gear fitted to a Tiger Moth Aircraft, and spraying insecticide T.P.5007. It appears that in the present case, the drop size of the ground deposit is considerably coarser. The table below compares the relevant parameters.

Parameter	Cessna Trial	Tiger Moth Trial
Airspeed (m.p.h.)	95	75
Windmill pitch (degrees)	27½	22½
Windmill diameter (inches)	13	18
Windmill r.p.m.	2500	6000
Cage r.p.m.	2500	15000
Cage diameter (inches)	7	4
Peripheral velocity (m.p.h.)	50	178
Resultant shear velocity at the cage periphery (m.p.h.)	107	193
Liquid surface tension (dynes/cm.)	73	28
Density (g/cc.)	1	0.87
v.m.d. (microns)	93	54
Evaporation (%)	44	78

The authors further note that the processes of rotary atomisation have been reviewed by Jarman (1957), and the relation put forward by Walton and Prewett (1949) for the spinning disc type of sprayer may be applied here.

i.e.

$$d = \frac{k}{\omega} \cdot \sqrt{\frac{T}{D\rho}}$$

where d = main drop diameter, ω = angular velocity of rotor.

ρ = density of the liquid

T = liquid surface tension

D = diameter of the rotor

K = a constant, depending on the nature of the rotor.

In order to compare two sprayers of similar pattern for differing operational conditions, the relation may be expressed as:-

$$d \,\alpha\, V \,.\, \sqrt{\frac{T.D}{\rho}}$$

where the value of V is here identified with the resultant air shear velocity, by combining the velocity due to rotation with that due to the forward motion i.e. the airspeed. On this basis we find that the ratio of the main drop diameters in these two trials should be 1.15:1. Neglecting the effect of evaporation and taking the v.m.d. as a measure of the main drop diameter, the experimental ratio is 1.7:1. The discrepancy between these two figures may be reconciled by making a correction to the measured figure which takes account of the differing evaporation rates for droplets of the two liquids. To a first approximation, the main drop diameter as emitted, may be obtained from the measured v.m.d. of the deposit by dividing by $\sqrt[3]{100 - \%\ \text{Evaporation}}$, and when this is done the ratio falls to 1.25:1. Thus the equation appears to provide a useful indication of the change in v.m.d. to be expected from a change in several of the relevant variables, under field conditions, provided evaporation can be reliably predicted.

The deposit density in the present case peaks between 30 and 50 yards downwind of the aircraft track, but the appreciable deposits recorded at a 100 and 125 yards downwind indicate that sedimentation deposition is still incomplete and is likely to continue significantly over a considerably longer distance, as experienced in the earlier trial. The deposit level is just under 1 gallon/acre/emission over a swathe width of about 40 yds.

Recovery is higher than that recorded for the Tiger Moth trial, consistent with the coarser drop spectrum and the lower measured evaporation.

ASSESSMENT OF THE RESIDUAL TOXICITY OF THE ORGANOPHOSPHORUS INSECTICIDES MALATHION AND BAYTEX TO ANOPHELES GAMBIAE

A. SMITH and K. S. HOCKING. Colonial Pesticides Research Unit, Arusha, Tanganyika, Miscellaneous Report No. 283, 8 pp., refs, 7 tables.

The authors preface their report as follows: The resistance of many insect vectors of disease to insecticides in common use has become a major problem in public health. To mitigate this problem, the World Health Organization has undertaken a programme of testing and developing new insecticidal compounds, as substitutes for the chlorohydrocarbons. Promising insecticides, as shown by tests in laboratories, are receiving further screening by the C.P.R.U. in the form of bio-assays in the laboratory of Arusha, with local materials and mosquitoes, and field trials at Magugu, a small village 100 miles south of Arusha. This paper gives an account of results obtained with two organo-phosphorus insecticides, malathion and "Baytex". Malathion has already been shown to be an insecticide of value in the field against a variety of pests, including culicine mosquitoes (Linquist 1957) and human lice (Hayes and others 1960), but less encouraging results were obtained against *Anopheles saccharovi* in Greece compared with Baytex (Rao and others 1960).

Method

Preliminary bio-assays were carried out in a Uniport 'Altent' - a prefabricated aluminium alloy building with panels of non-sorptive "Magugu" and sorptive "Babati" mud from the Magugu area. The residual toxicity of the insecticide was also studied on limewashed panels of sorptive and non-sorptive mud. The limewash was made up a few days before application and then applied a week before treatment by the insecticide. By this means, a limewashed wall was prepared that somewhat resembled the weathered surface of an average limewashed building.

Field trials were carried out in experimental huts already described by Hocking and others (1960) and Rapley (in press). The huts were modified a little to improve their attractiveness to *A.gambiae*. The walls were lowered to bring the eaves a foot nearer the ground, and two African sleepers instead of one sleeper employed for each hut. The walls were lined with a plaster of mud two inches thick, or with plywood, and the roofs were thatched with grass. Mud linings were either non-sorptive Magugu or sorptive Babati mud, and were limewashed in certain huts.

The insecticides were applied to the roofs and walls of experimental huts by means of an "Oxford Precision Sprayer", with the exception of two walls of each hut which were treated by the Poulton machine to provide even deposits for bio-assays. The intended dosages were 2 g/m for Malathion and 1 g/m for Baytex but the applications fell short due to insufficient allowance being made for fallout from the spraying equipment. For malathion, the mean dosage per hut, as determined by chemical analyses of treated papers, was 1.33 g/m between the limits of 1.27 and 1.46 for individual huts. The walls used for bio-assays averaged 1.83 g/m between limits 1.6 and 2.19.

The mean deposit of Baytex was 0.8 g/m between limits of 0.68 and 0.88. The walls used for bio-assays averaged 1.2 g/m between limits of 0.92 and 1.36.

Bio-assays were made according to the standard technique recommended by W.H.O. (Tech. Rep. No. 80). Exposure times were graded from ½ hour to 12 hours as mortalities fell below 75%. The test insects for the Arusha panels were three days old, recently fed *A.gambiae*, while wild caught blood fed *A.gambiae* were used for bio-assays in the experimental huts until insufficient numbers were obtainable for the tests, and then *A.gambiae* were used from the insectary at Arusha. All tests were duplicated, the average of both tests being used to express the percentage 24 hour mortalities.

The kills of naturally entering *A.gambiae* in the experimental huts were calculated from the daily numbers of dead mosquitoes on the floor plus the numbers captured in the window traps, that died after 24 hours. The sum expressed as a percentage of the total catch, of living and dead mosquitoes, gave the percentage mortalities in the huts. The catching techniques are described by Hocking and others (1960).

Conclusions

High mortalities were found among naturally entering *A.gambiae*, and in bio-assays. The authors consider that if the insecticides were applied at somewhat higher dosages e.g. Malathion at 2 g/m and "Baytex" at 1.5 g/m satisfactory mortalities might be obtained for at least 3 months in houses with thatched roofs.

Bio-assays and vapour toxicity tests showed that the roofs of the experimental huts were responsible for the greatest proportion of the kills among *A.gambiae* entering mud walled huts. This has been confirmed by other studies which have shown that about 80% of *A.gambiae* in an experimental hut, rest on the roof at night, and over 90% rest there during the daytime (unpublished observations).

In local huts, however, over half of *A.gambiae* rest on the mud walls during the daytime. From this observation, it would be supposed that the insecticide would be less effective in local than in experimental huts. In huts made almost entirely of mud, such as occur in Nigeria, one would expect the residual toxicities to be even more short-lived, and this point is now being investigated.

TOPICAL APPLICATION OF INSECTICIDES TO TSETSE FLIES. III CHLORINATED HYDROCARBONS TO WILD G. SWYNNERTONI AUST.

G. F. BURNETT. Colonial Pesticides Research Unit, Arusha Miscellaneous Report No. 287, 4 pages, refs, 6 tables, 2 figs.

Author's Summary: Wild *G. swynnertoni* have been treated with the insecticides DDT, gamma BHC, dieldrin and telodrin ('Shell' W.L. 1650) by topical application in kerosene solution. The order of increasing susceptibility was that given above and to all insecticides, males were found more susceptible than were young *G. morsitans* raised in the laboratory from wild pupae. The relative susceptibility of the two species ranged from 2.5 for gamma BHC and DDT to 3.8 for dieldrin.

Samples of wild females were significantly more tolerant to all insecticides than the males; this is considered a function of greater age and of pregnancy rather than a mere sexual difference although among females there is some significant correlation between greater body weight and survival. Unselected samples of females were about 2.8 times as tolerant of insecticides as males but pregnant females showed an eightfold increase in tolerance to DDT.

A PRELIMINARY STATISTICAL ANALYSIS OF INSECTICIDE DOSAGES IN EXPERIMENTAL HUTS

D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika, Miscellaneous Report No. 286 Feb. 1961, 4 pages, 2 tables, 1 fig.

The author comments: It is usual in our work to measure insecticidal dosages in various sites within experimental huts. Sample papers are used to collect the insecticide which is then estimated chemically. The technique is not ideal, but it is believed that samples collected in this way do give a useful measure of dosage, and it has not been possible to devise an alternative technique which is suitable for routine work.

This report describes a statistical analysis of a group of such samples, which was collected from four experimental huts sprayed on the 8th February, 1961. The huts were roughly 8 ft square with walls 5-6 ft high; two huts (Nos 15 and 16) had ordinary grass roofs, while the other two (Nos 4 and 10) had grass roofs internally faced with mud. In each hut two methods of spraying were employed. Two walls were sprayed with the Poulton Panel Sprayer, an electrically-driven device for moving a flatfan nozzle vertically at a constant speed, while the other two walls and the roof were sprayed with an Oxford Precision Sprayer, which is essentially a pneumatic, knapsack sprayer fitted with a fan-spray nozzle like that fitted to the panel sprayer. Two formulations (wettable powders) were used one containing 30% (w/w) of malathion and the other 40% (w/w) of "Baytex", and the intention was to achieve dosages of 1.5g of insecticide per sq.m. of surface. With the panel sprayer the insecticide was applied by single passages of the nozzle, spaced at intervals of 14 in. with the nozzle 18 in. from the wall, using suspensions containing 2.5% (w/v) of insecticide; the emission rate and speed of movement of the nozzle were such that, assuming that 70% of the spray reached the target, then 60 cc (equivalent to 1.5 g of insecticide) were applied per square metre of wall surface. For the applications with the Oxford precision sprayer enough insecticide was mixed up in 1.5 litres of water so that, again assuming a 70% recovery, 1.5 g of insecticide should have been applied per square metre of surface; the suspensions contained approximately 2.75% (w/v) of insecticide, and the speed of working was such that approximately three complete sprayings were possible during the application of the required dosage.

The sample papers each covered an area of 23.8 cm^2. Four were placed near the top of the roof of each hut, four near the bottom of the roof, and four from each of the walls areas sprayed with either the panel sprayer or the precision sprayer, thus giving a total of 16 samples per hut.

From the data, which is examined with regard to the degree of precision implicit in the experimental procedure, the author derives the following general comments: The samples from the walls treated with the panel sprayer were not well chosen; they were taken too near the edges of the areas sprayed by the machine and might well have been much more variable than were the dosages over much of these walls. A more detailed study of the data suggested that the variance of the samples taken from walls sprayed with the Oxford Precision Sprayer was considerably less than that of the roof samples, and that the roof and wall samples came from populations with different variance, so that more properly these two types of samples should perhaps be treated separately. Finally, it is also possible that an increase in sampling area might usefully improve the accuracy of sampling, and this should be investigated.

THE RETENTION ON MAIZE OF GRANULES, AS USED FOR THE INSECTICIDAL CONTROL OF STALK BORERS.

P. T. WALKER and M. SELWAY, Colonial Pesticides Research Unit, Porton.
Misc. Report No. 178. September 1960, pp7.

Granules, impregnated with insecticides, are widely used in America and are being tried in Africa for the control of Lepidopterous stalk-borers of maize. They have several apparent advantages over dusts and sprays for this purpose. They fall directly on to the plant without drift, they break up slowly when moist, releasing insecticide where it is required, and they are easy to transport and handle.

The main site of action of insecticides on the young larvae of *Busseola fusca* Fuller and other African stem borers, is within the central whorl of leaves, although some action may take place on the stem (Walker, 1960a). It is of interest, therefore, to know what proportion of the granules falling over the plant are retained by the different parts of the plant, and how these proportions are altered if the plant is wet and dry.

In these experiments "Attaclay" attapulgite, 30/60 T.S.S. granules were distributed over potted maize plants by means of a Cook "Granula" machine at a speed of ½ m.p.h. Variations in the treatments are described and the results are subjected to analysis.

Conclusion

Considerably more granules are retained by the leaves of a wet plant than by those of a dry plant. The proportion of granules on leaves to those in the whorl is 1: 3.4, for dry plants, and 1: 0.5 for wet plants. The amount retained by stems, mostly the leaf axils, does not differ significantly.

If the wet plant, with granules adhering is allowed to dry, and then shaken gently to simulate field conditions granules are lost from the leaves but accumulate in the whorl. The amount of granules remaining on the leaves is still significantly greater than that initially retained by dry leaves, indicating that granules are either sticking to or are trapped on leaves that have been wet.

When a plant is subjected to rain from directly above, there is a sharp loss of granules from the leaves, and corresponding increase in granules in the central whorl. There is also an increase in the amount of granules in the leaf axils after shaking and rain, but this is not conclusive.

The total amount of granules retained on the whole plant can be examined. Apart from a marked difference between two of the experiments that is almost certainly due to the greater leaf area of the plants there is little difference between treatments. Rain causes surprisingly little loss of total granules.

In general, the conclusion is that after rain and wind, little loss of granules occurs and the majority find their way into the central whorl.

SOME OBSERVATIONS ON THE ATTENUATION OF BAYER 73 IN FLOWING WATER

N. O. CROSSLAND and C. E. MCKONE. Colonial Pesticides Research Unit, Arusha. Miscellaneous Report No. 279. pp.7, refs, 2 tables, 1 fig.

The purpose of the present field trial was to investigate the downstream flow characteristics and stability of the compound in flowing water. The Nairobi river was selected as the experimental area firstly because the results could be compared with those of Foster et al., who carried out a field trial on this river in April, 1959, and secondly because the very slow rate of flow of the water at the time of the trial made possible an investigation of the downstream flow characteristics and stability of Bayer 73 in flowing water.

The authors state that the formulation (Bayer 4780, a 70% dispersible powder of Bayer 73) was dispersed by the constant flow apparatus devised by Foster and Poulton. The calculated dosage was approximately 2 p.p.m. for 6 hrs. The application was made below a dam where the river was diverted to allow for a gravity-fed water supply. Immediately below this diversion was a drop of two feet which ensured adequate mixing. A stretch of river 300 yds long above the dam was used as a control.

Results

Before treatment, and after treatment in the control section of the river, snails were collected in large numbers from all sections of the river. *Biomphalaria pfeifferi*, *Lymnaea natalensis* and *Bulinus tropicus* were very abundant. *Physa berbonica* was common and *Anisus sp.* and *Physopsis sp.* were also present.

For a period of seven weeks after treatment no adult or juvenile specimens of *Biomphalaria* were found in the mainstream of the treated portion of the river to a distance of 5,500 yds downstream of the application. Three weeks after treatment, however, large numbers of hatchlings were observed and *Biomphalaria* egg masses collected within a few days of treatment were hatched in the laboratory.

Very high mortality among adult snails (apparently 100% for *Biomphalaria*) were observed 5,500 yds downstream from the applicator where the dosage was only 0.07 p.p.m. for 16 hrs. The molluscicide did not arrive at this station until 64 hrs. after the beginning of the treatment and yet there was sufficient active ingredient in the water to give good snail control. Very high kills of *Bulinus* and *Lymnaea* were observed although small numbers of both of these species survived the treatment especially in the lower reaches of the treated portion of the river. Below 6,000 yds there was no observable biological effect nor could the presence of the molluscicide be demonstrated by chemical methods.

Immediately below the applicator fish showed signs of distress within three minutes of the beginning of the treatment and after fifteen minutes there were large numbers of dead fish, frogs and tadpoles. Farther downstream fish were dead after about ½-1 hrs exposure to a concentration as low as 0.1 p.p.m.

Comments: The authors point out that since the average width of the river is only about four or five feet and the average rate of flow was about 80 yds per hr there would exist a gradient of velocity across the width of the river i.e. friction near the banks would cause a fall off in the rate of flow near the banks when compared with the middle of the river. Therefore molluscicide in solution near the middle of the river would travel downstream more quickly than that near the banks. In larger or more swiftly-flowing canals and streams this effect may not be of any importance.

On this basis a shorter time of application and a higher initial concentration are recommended for slow-flowing streams than for swifter-flowing irrigation channels etc.

About 90% of the chemical was lost during the 72 hours following the beginning of the treatment. This loss of molluscicide can be accounted for by the operation of two main factors (a) the effect of U.V. radiation and (b) adsorption and absorption by mud and organic matter. It was considered that in the present experiment U.V. radiation did not materially affect the rate of dissipation of Bayer 73; it seemed more likely that the factors involved were (a) the spreading out of the chemical and (b) adsorption and absorption by mud and organic matter.

APPLIED TOXICOLOGY OF PESTICIDES*

E. F. EDSON, M.B., Ch.B., M.Sc.

About 70 different chemicals are used extensively as pesticides in agriculture and horticulture in Britain. Some of them, such as sulphur, copper, arsenicals, nicotine, mineral oils, mercury and derris have been used for many decades, but the majority have been brought forward during the 15 years since the end of the second world war. These new materials include the *chlorinated hydrocarbons*, DDT, BHC, heptachlor, dieldrin, endrin and aldrin; the *organophosphate insecticides* parathion, TEPP, schradan, malathion, dimethoate, demeton-methyl; new *organic fungicides* such as the dithiocarbamates, captan and TMTD; the *hormone-type selective weedkillers* such as 2,4-D, MCPA, 2,4,5-T, 2,4-DB, CMPP, MCPB, TBA; and new persistent *total herbicides* such as monuron, simazine and atrazine, to quote only examples.

Most of these chemicals are used all over the world, and toxicological or medical information concerning them comes from research organisations and agricultural or public health users in many countries. The files of one company's laboratory contains well over 1,000 reprints of published work bearing on the toxicology of agricultural pesticides, the majority from the literature of the past 10 years. Under these circumstances, no attempt can be made in this article to describe the detailed pharmacology, toxicology or medical aspects of any individual pesticide. The range of pesticidal preparations stocked by a pharmacist does not yet approach the complexity of the medicinal preparations for which he may be asked, but it is steadily increasing, and this trend will probably continue. An attempt will therefore be made to provide information which is generally useful rather than academically profound.

It is, however, a matter of interest that there are marked similarities in the objectives and problems of manufacturing organisations in the pharmaceutical and the agricultural chemical industries. There is an insatiable demand for "new products" either to "cure" new problems or to replace unsatisfactory or only partly-effective chemicals. There is a research interest in natural products, biological preparations and newly synthesised organic chemicals. The research effort preceding and accompanying newly introduced products is widely spread, of a high standard, and is found imperative for commercial progress. Technical objectives are often the same, i.e., selective toxicity, or at least selective safe interference with some organism or biological system adverse to man. Research on the best methods of formulating and administering the chemotherapeutic agents is common ground, as is the need for a high safety index in the products, because of the constant chance of dangerous abuse or misuse by the purchaser. There are even closer ties between these two branches of the chemical industry; sulphur, mercury, arsenic, borates, anticoagulants and certain antibiotics find important uses in both spheres. Many pharmaceutical organisations operate a parallel pesticide interest, their new chemicals being routinely examined both for pharmacological and pesticidal activity.

Footnote

*We are grateful to the Author, and to the Editor of the Pharmaceutical Journal, for permission to reproduce this article which first appeared in the Pharmaceutical Journal, 15th October 1960.

Background

Agricultural pesticides are specially formulated liquid or solid preparations of organic or inorganic chemicals, selected from large numbers of experimentally synthesised materials for their lethality, preferably selective lethality, to pest organisms, i.e., weeds in crops, other unwanted vegetation, insects, fungi, nematodes, molluscs, algae, rodents or indeed any living organisms whose "control" would be to man's local advantage. The large range of pest species to be controlled, either by selective toxicity or selective placement, dosage, or timing of application, makes imperative a wide range of chemicals and formulations. It is inevitable that there should be a marked variation in the degree and type of toxic hazards presented to man and animals by such a wide range of dissimilar chemicals[1,2,3]. Most (60-95 per cent.) chemicals used, in all countries, are materials of comparatively low mammalian toxicity, and consequently slight or negligible risk to users or the public. However, present-day knowledge of the mechanisms of selective toxicity is so scanty, and the discovery of compounds usefully exhibiting this property so difficult, that many of the chemicals used in crop protection and the control of disease vectors are of high enough mammalian toxicity to present potential risks to man and beneficial organisms.

Hazards

When such "toxic" materials are widely distributed and used in agriculture, often by persons who fail to appreciate the importance of the cautions given on the label or accompanying literature, risks may arise at any stage of use. Containers may be damaged in transit, and cause contamination of food, or those handling the consignment. The agricultural or public health user may be splashed by, or otherwise exposed to, the concentrated material when opening the container, or filling up his spraying equipment. He may absorb some of the chemical from repeated or prolonged skin contamination by the dilute material during spraying, or inhale the mist or dust, or swallow traces of the material from conveying it to the mouth by fingers, food, drink, or sucking or blowing out blockages in spray jets. Food crops may be harvested before a sufficient time interval has elapsed for the chemical to have disappeared from the edible crop by chemical degradation, volatilisation or the effects of growth and weather. Farm stock may lick up spillages, or break into a sprayed field. Careless storage of chemicals may leave them accessible to toddlers, and careless disposal of used containers or their washings may lead to accidental skin contamination, or accidental ingestion by stock or children, or the contamination of foodstuffs or water supplies. The easy availability of farm chemicals labelled "poison" could facilitate suicidal or homicidal activities.

All these risks have been demonstrated in the past decade by isolated incidents occurring in one or other country making extensive use of agricultural chemicals. They have therefore been given much attention at both national and international level. 2,5,6,7,8.

Most manufacturers of such chemicals in Britain are members of a trade association (the Association of British Manufacturers of Agricultural Chemicals) which for the past 10 years has had an extremely close liaison with the Government Departments responsible for agriculture and health. This has brought forward a series of agreed statutory and voluntary controls which have gone far to induce the safe use of pesticides in this country. In many ways, as exemplified below, these measures are more demanding and more thorough than those concerning even new medicinal preparations:

(1) Manufacturers (or main distributors in the case of imported chemicals) voluntarily submit to the Government detailed technical and toxicological data concerning any proposed new pesticide, new formulation, or new use, where experience from other compounds suggests that any risk to man or animals could arise. This data is submitted before marketing[9].

(2) The Government's specially created Inter-departmental Advisory Committee considers this data, and advises the Departments what safety measures seem advisable in each instance. Depending on the circumstances, a proposed use may occasionally be rejected as unsafe. A new chemical of high toxicity may promptly be brought within the provisions of the poisons legislation. If personal safety precautions by users seem essential, the chemical may be made a "Scheduled substance" under the Agriculture (Poisonous Substances) Act and Regulations. By this procedure, employers and employees are required, under penalty, to adopt specific safety equipment and methods of safe use. A chemical of high toxicity and great persistency on the vegetation may be restricted to use on non-food crops. If less persistent, according to the results of detailed "residue analysis" studies required for such submissions, it may be permitted for use on stated crops, as long as manufacturers invariably tell users that a "safety interval" of some days or weeks must elapse before harvesting. The agreed recommendations for use of any chemical may be revoked at any time, if subsequent findings make this desirable in the public interest.

(3) Panels of experienced scientists and administrators from Government and industry have co-operated to draw up recommendations for the safety information to be included on labels, on medical treatment of cases of poisoning by pesticides, and the type and amount of technical and toxicological information to be submitted when a new chemical is under consideration for marketing in Britain, dealing with risks in use, as a food contaminant, and to wild life.

(4) The Ministry of Agriculture has in almost every county an officer responsible for enforcing the statutory requirements for safe use of Scheduled substances, and the important effort of educating users is shared by the M.A.F.F. safety organisation, the Agricultural Advisory Services, and the manufacturing organisations. Any incident involving poisoning or risk of poisoning is therefore subject to thorough investigation, machinery existing for controlling any further risk.

The above control systems are tending to tighten rather than relax, and have already reached the stage that "clearance for use" is a significant early hurdle facing any new agricultural chemical of high or even moderate toxicity. It would be optimistic to hope, and wrong to presume, that any such systems could remove all possibilities of occasional fatal or dangerous misuse of chemicals of high toxicity. Farm chemicals share the potential problems arising from motor vehicles, new medicinal drugs, new materials of construction, and many other innovations, in that they demand care by the users. Agriculture in Britain employs nearly a million persons, and each year about one-quarter of our total farmed acreage of 30 million acres is treated with one or other pesticidal chemical. Most private gardens and horticultural holdings are likewise treated with some pesticide or other, so that each year astronomical numbers of tins or bottles of pesticidal products are distributed, stored, opened, diluted and applied as sprays or dusts. There are thus many thousands of occasional users concerned with the overall safety effort. It is therefore fortunate, but also the result more recently of deliberate research, that most pest problems can now be tackled reasonably well by the use of materials of low or very low toxicity to man and animals, which vastly reduces the magnitude of the safety problem.

Despite the somewhat alarmist and often imprecise articles and letters occurring in the national Press, this country's safety record with chemical pesticides is by no means a bad one. Since 1946 there have been only 13 fatalities among users (DNOC weedkillers, 9; organophosphate insecticides, 2; organomercurial fungicide, 1; arsenite herbicide, 1); only four deaths have occurred since 1951. As far as I can trace, there have been two accidental deaths only in members of the public (1959, arsenite potato haulm-destroyer accidentally syphoning back from spray tank into farmhouse water supply; and 1960, scrapyard worker unknowingly contaminated by organophosphate insecticide in old tin); a very small number of suicides (believed to be two in the past five years), and only one major instance of severe accidental food poisoning (flour contamination by the chlorinated hydrocarbon insecticide endrin, when a container leaked while in transit by rail, causing acute, dramatic but non-lethal food poisoning in a South Wales village). In the past eight years there have been about a score of authentic cases of minor temporary intoxications among farmworkers, mainly due to the DNOC-type weedkillers and the more toxic organophosphate insecticides. Distributed over so many years, and bearing in mind the vast acreages of successful pesticidal treatment by agricultural personnel, this type of safety record need give little alarm for the future. Shotguns, fires, lightning and explosions have in recent years caused as many farming fatalities in any one year as pesticides have caused since 1946[10].

Traces in foodstuffs

The possibility of unsafe residual amounts of crop protection chemicals remaining in the foodstuff at the time of consumption cannot be ignored by either manufacturers or Governments. The most elaborate system of control of this risk is found in the United States, where a system of legally enforceable "residue tolerances" is operated[11]. In Britain, reliance is placed on the devising, from experimental data, of a conservative "safety interval" between last treatment and harvesting the crop, and then making sure that all growers know this interval and of its importance to them and the public. Isolated instances have occurred in other countries where the necessary time interval has not been allowed, and minor illness followed the consumption of the unsafe crop. In Britain there have been no such occurrences, as far as is known. (This is not really surprising since it is possible to calculate that a chemical residue of about 50 parts per million would be required in a major dietary item to cause risk or serious poisoning in a 40 kilos adolescent by a material which had an acute oral LD_{50} of 5 mgm./kilo, and was markedly cumulative in toxic effects, during a week's daily ingestion.) From the practical point of view, there seems rather more cause for scientific and analytical interest in chemical residues in foodstuffs imported from less well-developed overseas countries than those grown in Britain, and in the possible problems of "deliberate" food additives than in those from "accidental" contaminants such pesticides. Food and Agricultural Organisation data for 1955-56, for the eight countries Greece, Peru, Brazil, Italy, Canada, Belgium, Japan and India, show that of a recorded 300,000 metric tons total annual usage of pesticides, 34,371 tons, or 13 per cent. of the total, consisted of chemicals of high or moderately high toxicity[4]. This proportional use of the more toxic products is two or three times greater than that applying in Britain, because of the latter's small fruit-growing industry, temperate climate and crops grown.

Prevention of hazards in use

Table I lists a large number of the most important pesticidal chemicals in modern use, and divides them into three arbitrary categories of increasing hazard, based on the acute toxicity of these materials in experimental animals, as modified by the medical history of the materials since they were introduced into agricultural or public health usage. Each of these products is likely to be available, from different suppliers, in different physical forms. Generally speaking, most formulations of pesticides are either *water-miscible liquids* (i.e., liquid concentrates in organic solvents or water, with added wetting agents); *wettable powders* (free-flowing powders comprising an intimate mixture of active chemical, inert carrier and wetting agent); *dusts* (dilute

TABLE I

Comparative Hazards of Pesticides

Main uses	*Safe*	*Intermediate*	*Hazardous*
Fumigants	Ethylene dichloride Formaldehyde	Carbon tetrachloride Chloropicrin Ethylene dibromide	Hydrocyanic acid gas Methyl bromide
Rodenticides	ANTU (α-naphthyl thiourea) Barium carbonate Red squill Warfarin		Barium fluoride Barium fluoride Fluoroacetamide Fluoroacetate Hydrocyanic acid Strychnine Zinc phosphide
Herbicides	Borates Carbamates (for example, IPC) Chlorates 2, 4-dichlorophenoxy-acetic acid (2, 4-D) and all related plant-growth hormones, including TBA Monochloroacetates Monuron (CMU) Simazine Trichloroacetates	Pentachlorophenol (also used as a timber preservative)	Arsenites Dinitrobutyl-phenol (dinoseb) Dinitrocresol (DNC) Sulphuric acid Endothal
Insecticides	Benzene hexachloride Chlorbenzide Chlordane DDD DDT Derris Dipterex Malathion Methoxychlor Mineral oils Pyrethrin Tar oils	Aldrin Chlorthion Demeton-methyl Diazinon Dieldrin Heptachlor Lead arsenate Phenkaptone Rogor Toxaphene	Demeton Dimefox Dinitrobutyl-phenol Dinitrocresol (DNC) Endrin Fluoroacetamide Guthion Methyl-parathion Nicotine Parathion Phosdrin Schradan Sulphotepp TEPP (HETP)
Fungicides	Antibiotics Captan Copper compounds Dithiocarbamates Lime-sulphur Sulphur TMTD (tetramethyl thiuram disulphide)	Organic mercurials used as seed dressings (1-3 per cent Hg)	Organic mercury compounds used as concentrates, or indoors
Growth depressants	Maleic hydrazide Tetrachloronitrobenzene		
Repellents	Naphthalene Paradichlorobenzene		

Safe - of low mammalian toxicity and correspondingly slight hazards in use.

Intermediate - of moderate toxicity, safe if used with some care. Care especially needed in hot climates, indoors and when handling concentrates.

Hazardous - of dangerously high toxicity and appreciable hazards. Require careful handling under almost all conditions.

(Reprinted from 'Modern trends in occupational health' (Butterworth, 1960), by kind permission of the publishers.)

high-bulk density preparations of active ingredient and fine inert carrier); or *aerosols* (solutions in highly volatile organic solvents in pressurised containers). The wetting agents used in such formulations are almost invariably innocuous, and neither present nor increase safety problems in the product; they do in fact ensure water-miscibility, and thus aid the decontamination of containers by washing-out. The solvents used include various naphthalenes, kerosene fractions, xylene, methanol, methylene dichloride, Arcton, and very many others, most presenting no specific problems in outdoor use, some presenting slight fire or vapour-toxicity problems if used indoors. Miscible solutions and wettable powders require dilution with water for use by spraying equipment or watering can: dusts and aerosols are used as supplied.

There are almost always many points of technical importance which the manufacturer must bring to the attention of purchasers, for example, the best time, dose and way of application, the crops unsuitable for treatment and the pests controlled. Some materials, being toxic, require specific warnings on the need for care in handling, and on the necessary interval between spraying and crop-harvesting. Thus, the manufacturer's label or leaflet accompanying the product, being the only link between the maker and user, is of extreme importance to both. The safety precautions listed for the more toxic materials, i.e., the Scheduled substances, are many and detailed, because it must be remembered that while some experienced users will know just how to handle the material safely, any container may get into the hands of a person using the material for the very first time. By law, the nature and amount (percentage) of active ingredient must be stated on the label for all Scheduled poisons, but many less toxic products, especially for horticultural use or for use by amateurs, have virtually no indication on the label of what they contain. Recently, there has been a demand that some indication should be given of the active ingredients present, for the sake of safety. It is hoped that before long all pesticidal products will give information on their composition, in enough detail to permit appropriate steps to be taken in the treatment of any case of accidental poisoning.

There is a steadily increasing realisation, both from laboratory and field experiments, that the major occupational risks of poisoning come from persistent skin contact with the concentrated material[13]. By comparison, the chances of lethal exposure by inhalation of mist or dust during outdoor use, or by accidental swallowing, are small. Thus, utmost cautionary emphasis is placed on speedy and effective washing of the skin when gross contamination by a toxic chemical has occurred, and for regular hand washing during use. Soap and water is perhaps the best safety equipment of all.

Indoor operations in greenhouses, domestic rooms, farm buildings, and food stores, being subject to less ventilation than outdoors, tend to permit higher atmospheric concentrations of vapours, mists or dusts than occur outdoors. With the safe chemicals, this matters little, but indoor use of the more toxic materials sometimes demands the use of suitable respiratory protection. Other than for the materials listed in Table I as fumigants and for a few of the Scheduled substances, it is not necessary to use a charcoal canister respirator of Services, Civil Defence or industrial type, the use of a simple nose and mouth mask being sufficient to entrap airborne particles. The filter pads of such masks need changing frequently, however, i.e., every day or week, depending on the scale of use.

In general, the safety precautions listed by manufacturers are entirely adequate to protect users of even the most toxic products, if they are adopted. The absence of safety precautions on label or leaflet may safely be taken as implying that none are necessary, other than perhaps the commonsense one of keeping any concentrated chemical out of range of any child who cannot read.

Skin sensitivity

Contact dermatitis due to agricultural pesticide formulations is surprisingly rare. Apart from very occasional cases of individual hypersensitivity to the solvent or wetting agent used in the preparation handled, the few reported cases have been due mainly to contact with and individual hypersensitivity to, for example, sulphur, TMTD (thiram, tetramethylthiuram disulphide), PCP (pentachlorophenol), DDT, or DNOC (dinitro-*ortho*-cresol). Sulphuric acid, tar oils and lime-sulphur are primary skin irritants. Pyrethrin and TCA (trichloracetate) cause rare cases of urticarial response. Many cases of hypersensitivity to one or other plant or natural material occur among gardeners and farmworkers; the presumption can never be made that a pesticide used in gardening or agriculture has been the cause of a skin reaction. Patch testing, or a specific recurrence on further use or exposure, is always needed before advice to cease using a particular material is really justifiable.

Toxicity and toxicology of selected materials

Table II lists many important pesticides, and gives their acute oral and dermal LD_{50} values in the rat. All figures are in terms of mgm. active chemical per kilo bodyweight, so that for a 10 per cent. formulation the value would be increased ten-fold. There is always much controversy as to whether data on the rat can be regarded as representative of toxicity to man, i.e., is the susceptibility of man to a chemical similar to that of the rat? There are many occasions where this is not true, but generally speaking, it is those chemicals listed in Table II as most toxic to the rat that have caused most cases of intoxication among industrial employees and agricultural users. In the following paragraphs on specific materials, only brief mention will be made of the chemicals assessed in Table I as "safe", simply because the probability of their causing serious occupational or domestic poisoning is correspondingly small.

Insecticides

It is hardly surprising that the production of an effective insecticide virtually non-toxic to man, mammals, birds or fish is much more difficult than for herbicides or fungicides. The metabolic pathways and physiological mechanisms of insects are apparently much more similar to those in man than those occurring in plants or fungi.

DDT and BHC (benzene hexachloride) are by no means the least toxic insecticides now available, but their established value and almost clean safety record (apart from a few examples of poisoning by gross misuse or ingestion of the concentrated liquid preparations containing kerosene or other organic solvent), have made them almost classical examples of useful safe chemicals[12]. Controversy still exists in academic circles as to the chances of eventual disorders from the fact that the average diet, especially in North America, leads to some demonstrable accumulation of DDT in the tissues, but nearly two decades of apparently quite safe use are reassuring in that respect. In animals lethally affected, disorders of neuromuscular co-ordination and muscular tremor are the most striking toxic effects. There is no specific laboratory diagnostic test nor specific antidote.

New types of chlorinated hydrocarbon insecticides have been brought forward in dieldrin, aldrin and endrin, all three being very closely related chemically, endrin proving appreciably the most toxic to animals. Disorders from high doses in animals and birds are characterised by anorexia and convulsions, which may be delayed days or weeks after dosage. The convulsions may be violent, and cause unconsciousness, but are nevertheless fully recuperable, with time. Dieldrin has recently tended to usurp the place of DDT and BHC in public health use overseas where insect-resistance has occurred, and large numbers of cases of mild or severe but non-fatal human poisoning by dieldrin have been reported[13]; again the symptoms are often delayed for days or weeks after use, and comprise severe convulsive episodes, often with temporary unconsciousness, as in epilepsy. Much the same effects occurred in the food-contamination incident involving endrin in South Wales[14]. Even very severe and swift convulsive attacks are not necessarily lethal, and are much reduced or aborted by thorough barbiturate sedation. There is as yet no specific laboratory diagnostic method, and no specific antidotes for these materials.

The organophosphate insecticides are a very important post-war development. Although different members of the group vary in acute mammalian toxicity from oral LD_{50} of less than 1 mgm./kilo up to over 2000 mgm./kilo, their mode of toxic action and symptoms are the same. Both in mammals and insects, the transmission of the nerve impulse to gland, muscle or nerve cell is by the liberation of a mediator substance, acetyl choline, which is normally then hydrolysed almost immediately by one of a series of enzymes, the cholinesterase enzymes, present at such locations. Materials such as eserine or prostigmine also inhibit cholinesterase enzyme in a temporary and reversible fashion, and are therefore able to prolong and intensify the response to a nerve impulse, for example, as in myasthenic patients. The organophosphate insecticides are almost irreversible inhibitors of this enzyme, by phosphorylation. Thus absorption of such materials by man or insects inhibits first the enzyme reserves present in the tissues and then the vital cholinesterase traces remaining at nerve endings and synapses. Acetylcholine then accumulates, and in mammals a whole train of toxic effects occurs, involving disordered excessive secretion of sweat, lachrymal fluid or mucus; disordered muscular co-ordination, miosis, bladder contraction, colic, fibrillary twitching of voluntary muscle groups, bronchial constriction; eventual paresis and then paralysis of breathing muscles, with death from asphyxia and bradycardia[15]. Some such insecticides are not totally irreversible inhibitors of cholinesterase, and in these cases rapid amelioration of effects occurs, after the absorbed dose has been either detoxified or fully utilised in phosphorylation. In most cases, however, enzyme inhibition is irreversible, and after non-lethal dosage, cholinesterase concentrations only increase by the slow regeneration of more enzyme.

The blood of man, animals and birds contains cholinesterase enzyme at fairly stable levels in normal health, and since there are virtually no known lethal inhibitors of this enzyme except eserine, prostigmine and the organophosphate and some carbamate insecticides, measurement of blood cholinesterase levels is therefore an invaluable means of detecting unsafe working methods or of confirming that an illness is due to such cause. Several methods of measuring "ChE" enzyme exist, suitable for the research laboratory, hospital laboratory or emergency conditions[16], [17]. Experience to date is that organophosphate poisoning is always associated with marked and readily determinable ChE inhibition.

Two specific therapeutic measures exist in acute organophosphate poisoning, and should be put into operation immediately in any obviously serious case. The first, the injection of atropine sulphate (i.v. or i.m. or s.c., dosage of 1/30 grain (2 mgm.) every 15 to 30 minutes while needed), antagonises many of the lethal effects of accumulating acetylcholine. Atropine saturation is usually only needed for 12 to 36 hours, as by then the causative insecticide will have been detoxified, and a small but adequate amount of new or regenerated ChE formed in the tissues. Recovery thereafter is usually uneventful, but normal ChE levels may not be restored for up to three months. The second therapeutic weapon is one or other of the recently discovered cholinesterase-reactivating "oxime" compounds, for example, pyridine-2-aldoxime methiodide (P-2-AM) or methyl methane sulphonate (P2S). These materials are not yet generally available, but arrangements have been made for supplies to be provided urgently for any suspected case of poisoning, as described in a recent article on poisoning by organophosphate insecticides[18].

The names of individual organophosphates are provided in Table I, and Table II lists their acute LD 50.

Table II

Comparative Acute Toxicities of Important Agricultural Pesticides in the Rat

Note. - With the exception of figures in parenthesis, which are drawn from the published literature, all data are from experimental work in the Medical Department, Fisons Pest Control Ltd. (1952-59). Wherever possible, data refer to commercial formulations, but are expressed in terms of mgm. active ingredient/kilo bodyweight. The dermal toxicity test used involves a 24-hour contact period with the skin covered by adhesive waterproof plaster, following by thorough decontamination. > signifies highest dose tested. Gaps signify no reliable data available. This Table has been compiled with the assistance of Mr. D. M. Sanderson and Miss D. N. Noakes, gratefully acknowledged.

Type of Product	*Reference name*	*Acute single-dose LD_{50} value (mgm./kilo)*	
		oral	*dermal*
Herbicides	Endothal	80	750
	Dinitrocresol (DNOC)	40	> 600
	Dinoseb (DNBP)	50	200
	Arsenites (Na/K)	70	150
	Pentachlorphenol	80-200	
	2, 4-D: 2,4, 5-T	(400-700)	
	MCPA: MCPB: 2, 4-DB: TBA: CMPP.	700-1500	> 800
	IPC: chloro-PC	1000-4000	
	Chlorate	(1200)	
	Eptam (EPTC)	(1600)	
	Borates	(2000)	
	Aminotriazole	(2500)	
	Atrazine	(2000)	
	Monuron	(3500)	
	Trichloroacetate	(5000)	
	Simazin	> 5000	
	Dalapon	(6600)	
Fungicides	Organomercurial compounds	(30-70)	
	Ethyl mercuric chloride	30	200
	Phenyl mercuric chloride	60	
	Copper compounds	(150-800)	
	Copper oxychloride	700-800	
	TMTD (thiram)	(865)	
	Dithiocarbamates (maneb, zineb)	(> 1000)	
	Dithane	> 8000	
	Captan	(9000-15000)	
	Sulphur	(non-toxic)	
Insecticides (non-organo-phosphorus)	Endrin	3-5	60
	Isolan	12	
	Isodrin	(12-17)	
	Nicotine	(10-50)	
	Fluoroacetamide	(15)	80
	Dimetilan	25	600-700
	Thiodan	35	
	Heptachlor	40	
	Dieldrin	40	> 100
	Aldrin	40-60	> 200
	Toxaphene	(60)	(80-2300)
	Lead arsenate	(100)	
	Dimetan	(140)	
	BHC	200	(500)
	DDT	300	(2500)
	Chlordane	(400)	(700-1000)
	Sevin	(500-700)	
	Chlorbenzide (chlorparazide)	(2000)	
	Methoxychlor	(6000)	(6000)

Type of Product	*Reference name*	*Acute single-dose LD_{50} value (mgm./kilo)*	
		oral	*dermal*
Organophosphorus Insecticides	Dimefox (hanane)	2	1-4
	TEPP	0.5	20
	Thimet	3	80
	Phosdrin	3-4	90
	Parathion	3-6	75-200
	Demeton	4	200
	EPN	(4-8)	(25)
	Schradan	5	50-100
	Trithion	10-30	800
	Guthion	11	300
	Methyl parathion	12	
	Ethion	13	1600
	FAC 20	14-25	100-200
	Phosphamidon	15	125
	Endothion	25	130
	Thiometon	25	> 200
	Delnav (AC 528)	30-40	350
	Demeton-S-methyl	40	85
	Phenkaptone	45	> 1000
	Demeton-methyl	50-75	300-400
	Dition	67	> 200
	Dimethoate (Rogor)	200-240	750-1150
	Diazinon	300-400	> 1000
	Dipterex	650	> 2800
	Chlorthion	(900)	(1500-4500)
	Malathion	1400-1900	(> 4000)

Fungicides

Copper compounds have been used in agriculture for over 80 years, and Bordeaux mixture, copper oxychloride, oxide and other compounds are still important materials in farming and gardening. Occasional instances of risk to farm stock have occurred (for example, cattle licking up spillages, or sheep grazing beneath recently copper-sprayed trees), but there are no authentic cases of agricultural poisoning reported from this prolonged and often hygienically haphazard usage.

More recently, new synthetic fungicides have been introduced, e.g., captan, and the dithiocarbamates zineb and maneb. Again these are materials of very low toxicity in experimental animals, and presumably no real hazard to human users. One other material, tetramethyl thiuram disulphide (TMTD) is of some passing interest in its chemical and pharmacological relationship to a material used in the chemotherapy of alcohol addiction, and does itself sometimes cause profound discomfort and facial flushing in beer-drinking farmworkers using TMTD in a casual fashion.

Possibly the most hazardous fungicidal materials are the alkyl organomercurial compounds. These have a bad medical history (under conditions of prolonged incautious use as seed-dressings or soil sterilisants in greenhouses) of producing occasional cases of progressive and eventually lethal degenerative changes within the central nervous system, first shown as tremors, incoordination of fingers and limbs, proceeding to gross incoordination, much as in Parkinson's disease[19]. The volatility of these alkyl-substituted forms is far higher than the aryl-substituted materials now more generally favoured for seed-dressings, and they also appear to exert appreciably more toxic effect on the C.N.S. Seed-dressing carried out with mercurial products under dusty or ill-ventilated conditions, especially for the prolonged periods sometimes applying in seed merchants' premises, is potentially a hazardous process when the alkyl-mercurial materials are in use. The toxic effects are quite insidious, and mainly irreversible, causing five to

15 years' distressing progressive illness. Cases are rare, but may still arise under bad conditions of use. Unsafe working conditions can be detected by the laboratory diagnosis of mercury excretion levels in the urine, but there is no specific antidotal treatment in established cases of mercurialism.

Herbicides

The introduction of the selective "hormone" or growth-regulant weedkillers such as 2,4-D, 2,4,5-T, MCPA, MCPB, 2,4-DB, CMPP and TBA in the course of the past 15 years has probably caused more improvement in cereal crop production in Britain than any other single innovation. All are materials of very low toxicity indeed; doses of 700-1500 mgm./kilo are required to cause acute or lethal poisoning in animals (irritability, jactations, convulsions and finally coma), and it is gratifying to be able to state that despite vast scales of use in North America, Britain, Europe, Africa and the Far East, no instances of fatal intoxication have been recorded among users. Research has steadily increased the numbers and properties of this invaluable series of compounds, and in Britain they have gradually and properly replaced the far more toxic and troublesome dinitro-weedkillers for very many purposes.

The only herbicides which are likely to present significant health and safety problems under British conditions of climate and use are the dinitro-compounds and alkaline arsenites. Arsenites, introduced for potato-haulm destruction before mechanical harvesting when sulphuric acid shortage made this necessary some years ago, have caused such casualties among farm-stock, and are so much associated with insidious poisoning in the minds of the public, that it is now agreed by industry and Government that no further use will be made of them in Britain after 1960, at least as herbicides. The alkaline arsenites, being freely water-soluble and almost tasteless in lethal concentrations, naturally present far more serious problems than the much less soluble arsenates, such as lead arsenate, which has a long, useful and quite honourable record in fruit-orchard spraying campaigns in Britain and most countries. Low grade poisoning by lead arsenate is more likely to be seen as lead poisoning than as arsenical poisoning, due to the different toxicological properties and fates of the two elements in the human body. The diagnosis of arsenite poisoning is by determination of urinary arsenic excretion, and dimercaprol is specifically useful in promoting the excretion of acute overdosages in man.

The dinitro-weedkillers, DNC or DNOC (dinitro-orthocresol) and DNBP or dinoseb (dinitro-*sec*-butylphenol) still have specific places in agriculture despite their known high toxicity, because they control certain important weeds which are insensitive to the growth-regulant hormone weedkillers, or they are safer than hormones to the underlying crops, for example, peas, lucerne, clovers, DNC has been known as a vivid yellow dyestuff for several generations, and along with dinitrophenol was widely but hazardously used as a slimming agent 30 years ago, being discontinued when lens opacities, hepatic degeneration and other miscellaneous toxic effects arose in a fair proportion of recipients[20]. There have been several fatalities from the acute toxic effects of DNC among professional spray operators in Britain[21], the last in 1951, and minor intoxications still arise occasionally at the height of the DNOC weed-control campaign in May-June. These agricultural cases have been quite different in nature from the medical cases of 1932-33. Farmworkers using these materials before the importance of skin cleanliness was fully realised bore obvious signs of repeated exposure, by the vivid and lasting yellowness of their hands, hair and other exposed skin. The toxic effect of the dinitro-compounds in acute or cumulatively acute dosage is to cause a vast increase in cellular metabolic rate, by a specific blocking action on the oxidation-phosphorylation cycles of carbohydrate metabolism. Thus, the tissues produce far more heat; when this happens under conditions of severe external stress - for example, a June heatwave - then the worker may abruptly become seriously ill, with fatigue, thirst, profuse and dramatic sweating, mental confusion, dyspnoea, cyanosis, with a rapid onset of fatal coma. Such cases could still occur, as the dinitro-chemicals are not yet fully replaced in the spray chemical campaigns. The diagnosis of early dangerous stages of intoxication is fairly simple; the victim is yellow-handed, probably yellow-clothed, sweating profusely and feels exhausted. The analysis of his blood for the characteristic absorption band of DNC or DNBP will be strongly positive, and concentrations of more than 30 μgm./mil of DNC may be found in his whole blood sample. With no further exposure, and plentiful fluids and strenuous measures to cool him down by wet sponging, etc., the patient will excrete the dangerous load of chemical within a few days, and most of the remainder within two-three weeks. Any further exposure, or heat exposure, of a man in the early stages of intoxication may precipitate a fatal episode. There is unfortunately no specific antidotal therapy for DNC poisoning, treatment being therefore entirely symptomatic, with emphasis on fluid replacement, oxygen therapy for dyspnoea and deliberate attempts to reduce body temperature. (It is worth noting that the continuance of physical work by persons suffering from possibe organophosphate or dinitro-intoxication should be absolutely forbidden, and they must be made to refrain from exertion. Physical work liberates more acetylcholine than rest, and this may be fatal in early organophosphate poisoning; it also causes heat-production, and this may prove rapidly fatal in serious cases of dinitro-intoxication.)

Sulphuric acid, usually in a highly concentrated form, is used extensively in potato growing areas for withering the haulm of plants before mechanical harvesting. Its violently corrosive nature is well known to users, but accidents producing severe skin burns or eye-burns are always a possibility. The experience of the chemical industry is that immediate dilution of the splashed area by flooding with water, followed by thorough and prolonged washing of affected skin areas with soap and water, with at least 15 minutes eye-irrigation by water or any bland aqueous solution, is the vital first aid. The emphasis is on speed of acid removal, then completion of acid removal; attempts to carry out chemical neutralisation on the skin or eye-surface are often advocated, but more by chemically-inclined thinkers than by experience. The after-care of such areas is in no way different from burns due to other causes, i.e., thermal burns.

Advice to the pharmacist on emergency measures

(1) Ascertain the categories of the pesticide products (and their toxic properties) you or your local colleagues sell, or which are used in your area.

(2) If an obvious emergency case of poisoning arises, find out as quickly as possible what product has been concerned, or most probably concerned.

(3) If you can get the container in which the product was packed, or a similar container, look at the manufacturer's safety recommendations and first-aid instructions, if any, on the label or leaflet, and carry them out.

(4) Obtain medical assistance, either by asking a doctor to come, or by taking the patient to a doctor, or to hospital, depending on circumstances. Take or send the container, label or leaflet with the patient.

(5) In emergency and the absence of medical help or advice, administer any active emetic, if you feel sure from what you are told that the material has been swallowed.

(6) If the material has not been swallowed, but splashed over the person, arrange prompt and thorough washing of all splashed areas with soap and water, and the removal of contaminated clothing.

(7) If the medical practitioner has no previous experience of such cases, you or he should contact the manufacturer direct.

(8) Save any container, clothing, vomit or other "evidence" for any eventual formal inquiries.

(9) If such cases do appear to be a distinct occasional possibility in your area, make sure that you have atropine sulphate and oxygen available in reserve. Find out also the nearest medical establishment holding stocks of the organophosphate antidote P-2-AM or P2S (see THE JOURNAL, August 27, p. 190).

(10) As a preventive measure, you would often be justified and possibly of great service in pointing out to a customer that he had purchased a pesticide of poisonous nature, and the need for care in handling it and disposing safely of its contents and the container when empty.

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STATISTICAL SERVICE - ROTHAMSTED EXPERIMENTAL STATION

In 1954, through the courtesy of the National Research Development Corporation, the Agricultural Research Council was able to hire from the Corporation an "Elliott 401" Electronic Computer which was installed at Rothamsted Experimental Station. This proved a most valuable arrangement, which has greatly facilitated the analysis of experiments, not only for Rothamsted, but also for the field experimental programme of the N.A.A.S. and for a number of outside bodies both at home and overseas. In the five years that the computer has been in operation the number of experiments analysed has risen from 419 in 1955 to 2,649 in 1959. At the beginning of 1960 the "Elliott 401" was running virtually to the limit of its capacity and, in view of the increasing demands being made on the statistical service, and the need for more complicated and extensive analyses, it became apparent that a larger and more efficient machine was required. An order was accordingly placed for a Ferranti "Orion" Electronic Computer which will be installed at Rothamsted in the autumn of 1962.

The computing speed of the "Orion" is of the order of 25-50 times that of the "Elliott 401" and, with suitable ancillary equipment, the input and output of information will be about ten times that of the "Elliott". At first sight it might appear that this increase in capacity will be more than is needed by the Statistics Department of the Station. There are, however, some types of analysis which require heavy computing and which cannot be fully processed on the present machine. The improved programming facilities of the "Orion" together with its greater computing speed and larger capacity, will make it possible for the Department to extend its statistical service, particularly in the field of genetics, in the analysis of surveys and in processing continuously-recorded data of the kind that are regularly accumulated in agricultural research laboratories.

The acquisition of this new machine will enable the Station fully to maintain the considerable contribution it has already made to the development of computer techniques in research statistics and of statistical methods which ensure that the greatest possible amount of information is obtained from experiments with a minimal increase in the experimental effort.

(Report of the Agricultural Research Council for the Year 1959-60.)

NEW AFRICAN BEDBUGS

Bedbugs that attack bats were collected recently in Egypt and in the Belgian Congo - areas that represent diverse types of habitat.

One remarkable genus - *Stricticimex* - was described five years ago from South Africa. Last year another species was discovered by dynamiting rock cliffs in the Sahara Desert. Later a third species - which transmits Trypanosome parasites in bats - was discovered in a cave on the shores of Lake Tanganyika.

A new species of the genus *Leptocimex* was found in a tunnel dug by grave robbers centuries ago in the smallest of the three great pyramids at Giza. The discovery is exciting because the new species has the most highly evolved internal reproductive system of all bedbugs. The spermatozoa are transported through closed tubes from the base of the abdomen to the ovarioles, without the free migration in the body cavity which is typical of most other bedbugs. The new *Leptocimex* has also a double tubular structure, so that eggs may be fertilized on either the right or the left side of the abdomen. This represents the final stage in the evolution of the reproductive structure and helps to interpret the development of the group as a whole.

Live colonies of several species have been established in Berkley, so that studies may be made on their biology and host selection.

(California Agriculture, April 1961, *15*, (4).)

STORED PRODUCTS FUMIGATION IN SCOTLAND

The inspection of ships and their cargoes at Scottish ports continued, a total of 43,000 tons of imported goods being fumigated on the Department's recommendations. Some 28,000 empty sacks also were fumigated. Reports on infestation in cargoes continued to be sent to certain exporting countries so that such cargoes could be protected in future.

At the instigation of the Department two millers fumigated bags to be filled with government-owned 'Premium' flour. Arrangements were made with the Ministry of Agriculture, Fisheries and Food for firms operating the buffer depots in which 'Premium' flour is stored to carry out routine protective cleaning and spraying. The Clyde Navigation Trust agreed to undertake in addition to cleansing measures following the discharge of certain cargoes, control measures against endemic infestation in dockside transit sheds. As in previous years, advice was given to local authorities on request.

Methyl bromide, considered to be a more effective fumigant than other gases, is becoming generally used by servicing companies for the fumigation of mills; two flour mills and a pulse were so treated during 1960. Fumigation with hydrogen cyanide is becoming much less common. Methyl bromide was also used to fumigate machinery and Government-owned stocks of canned meat stored in air-conditioned plastic enclosures. At all of these treatments, measurements of gas concentrations and the effect on test insects were recorded by the Department's Scientific Services.

At four large grain-storing premises machinery was installed for admixing malathion dust with the grain before storage. This insecticide has some odour but has the advantage of being effective against insects at a dosage which is not harmful to humans; at the moment it is the most practical way of combating infestation by *Oryzaephilus surinamensis*. Dieldrin is one of the more effective insecticides against the ubiquitous spider beetles but as it is also one of the more toxic to humans it is used in limited circumstances and generally in the form of a lacquer. During the year it was used in other formulations - as a smoke, dust, or spray - in circumstances where contamination of foodstuffs could be avoided.

(Agriculture in Scotland, Report for 1960. Department of Agriculture and Fisheries for Scotland).

MALARIA ERADICATION

The WHO's expert committee on malaria has issued its eighth report and we give below some notes from this.

Out of a world population of 2,800 million 1,300 m. live in malarious or formerly malarious zones.

The disease has been eradicated from areas inhabited by 280m. people and another 697m. are in eradication schemes. Preliminary activities are under way for another 137m.

Causes of failure of schemes can be technical, operational or administrative. Technical failure has occurred where exophilic vectors have carried a reserve of the disease after endophilics have been killed by residual spraying. The problem of mosquito resistance to insecticides has the greatest bearing on the future of malaria eradication.

By April 1960 31 anopheline sps. were found to be resistant to one or the other, and a few to both groups of, chlorinated insecticides.

A resistance of malaria parasites to pyrimethamine has led to curtailment of the use of this drug. On the whole malaria eradication is pressing towards its goal.

Anti-malarial drugs play an essential part in the late phases of malaria eradication campaigns but it is now recognized that at times they also have a place in the attack phase.

The most effective standard drugs for acute malaria are the 4-amino-quinolines.

Encouraging results were obtained in the medicated salt project in Brazil.

Research is being extended on simian malaria and its relationship to malaria elimination.

(World Health Org. Tech. Rep. Series No. 205. Expert Committee on Malaria Eighth Report. Geneva, 1961. 3/6d.)

INSECT DISINFESTATION, AIRCRAFT

The WHO has issued a report on this subject and we are endeavouring to acclimatise ourselves to the word that has been coined, expressive though it be, to describe this operation - "disinsectation".

The report points out the unsatisfactory nature of present procedures, that of discharging an aerosol in the aircraft just before landing or after landing, by airport officials. In both these procedures insects may either be missed or escape.

WHO now recommends disinsectation just before take-off, at the "blocks away" stage and that one-dose dispensers should be used or multiples of such dispensers. The standard WHO reference aerosol is:-

Pyrethrum extract (25% pyrethrins)	1.6%	by	weight
DDT technical	3.0%	"	"
Xylene	7.5%	"	"
Odourless petroleum distillate	2.9%	"	"
Dichlorodifluoromethane	42.5%	"	"
Trichlorofluoromethane	42.5%	"	"

Capacity of the dispenser not more than 493 cm^3

WHO are not satisfied with the results given by aerosols, mostly because of their failure to penetrate everywhere and are turning their attention to vapour disinsectation. A promising product is DDVP (dimethyl 2, 2-dichlorovinyl-phosphate)

(AIRCRAFT DISINSECTATION Anon. World Health Org. tech. Report Series No.206 Geneva. price 1/9d, $0.30, Sw. fr. 1.)

METHODS OF APPLICATION

Aircraft

On the 19th April 1961, Dr. W.E. Ripper gave a paper at the Royal Aeronautical Society entitled "A review of Current Developments" in Agricultural Aviation. In his own inimitable style Dr. Ripper gave a brilliant exposé of the situation and the following is his summary:

> "Work study has produced a new formula to calculate the performance of spraying aircraft and this is used to discuss the advantages of the latest developments of agricultural aircraft such as the Piper Pawnee, the Snow, the Calibri Helicopter, and the Benson and Umbaugh Autogiros.
>
> Recent work on spraying efficient droplet size, the biological effect of spray and the danger of spray drift, has demonstrated that, for agricultural spraying, droplet size of a Sauter Mean Diameter of approximately 200 is effective; that redistribution of the spray deposit through dew, rain on the leaves, or systemic action in the plant, is necessary for most pesticides; that elastic spray droplets, rearward discharge of the spray nozzles and very low flying are adequate to prevent most drift problems.
>
> Ram-air fertilizer distributors are adequate for fertilizer spreading or seeding by aeroplane, but for rotary wing aircraft a new spinning disc distributor constitutes the best fertilizer - spreader proposed to date. While electrostatic precipitation of the spray droplet is unnecessary for most spray application in this country, an electrostatic precipitation of pesticide dusts has shown great advances for aerial dusting.
>
> A better utilization of the aircraft employed in agricultural aviation can now be obtained by extending the spraying season through the use of new pesticides: on potatoes, blight prevention can be complemented by aerial haulm killing with a new desiccant called 'diquat'. Pasture renovation on low land or on hills can be achieved by the control of unpalatable and unthrifty grasses with dalapon - "chemical ploughing", - and the control of perennial weed grasses by the aerial spraying of stubble in wet autumns is now possible with dalapon.
>
> The addition of fluorescent substances to pesticides permits a convenient method of inspecting the spray deposits on the plant by a daylight viewing chamber or in the ultra-violet light of a Wood's lamp at night, and this constitutes an important way of improving the accuracy of aerial spraying.
>
> Agricultural aviation is an important modern tool to enable the British farmer and horticulturalist to adapt his operation speedily to the great variations in climate from year to year and to carry out the correct operation despite adverse conditions."

Great interest was taken in the adaption of the Baltin formula made by Dr. R.C. Amsden. This is

$$\text{minutes/acre} \quad \frac{TrQ}{Qf} + \frac{165}{bv} + \frac{4840\ Tw}{60\ bL} + \frac{120aQ}{VQf} + \frac{60C}{VF}$$

$$\text{or } T = Tr + \frac{165Qf}{Qbv} + \frac{4840TwQf}{60Qbl} + \frac{120a}{V} + \frac{60CQf}{VFQ} \quad \text{(minutes)}$$

Tr = minutes spent on ground (filling and servicing)

Q = gallons/acre required dosage (or lbs)

QF = gallons spray carried per load (or lbs)

b = swath width in yards

v = spraying speed in miles/hour
T_w = turning time in seconds
L = length of field in yards
a = distance airstrip to fields in miles
V = ferrying speed in miles/hour
C = distance between fields in miles
F = area of field in acres
T = minutes per spray cycle = tQf/Q
t = efficiency (minutes/acre)
All figures being expressed as averages.

Other useful equations are:

1. Required spray output = $\frac{Qbv}{165}$ gallons/minute

2. Acres sprayed per trip = $\frac{Qf}{Q}$ acres

3. Acres sprayed per hour = $\frac{60Qf}{TQ}$

4. Cost per acre (shillings) = £ $\frac{TQ}{3Qf}$

   (direct cost per hour of aircraft + pilot cost/hr.)

At question time a number of aircraft-spray contractors spoke of the difficulty of carrying out work profitably at the current contract price.

NEWS ITEMS FROM THE U.S.A.

1. **Control of Aircraftborne Pest:** All planes arriving at New York from Paris are being sprayed with insecticides to destroy a foreign beetle that threatens American Agriculture, the U.S. Department of Agriculture reports.

This major European plant pest, a chafer not found in North America, has suddenly appeared in numbers on airplanes arriving from Paris at Idlewild International Airport. The reddish-brown beetle, *Melolontha melolontha*, belongs to the same family as the destructive Japanese beetle, which costs American farmers and city dwellers $10 million annually.

Other measures being taken to prevent the insect's entry into this country include sending a plant quarantine inspector to Paris to work with airlines and French authorities in an effort to eliminate the pests from planes before they take off for the U.S.

Under a programme of the ARS Plant Pest Control Division, long-lasting soil insecticides are being applied to more than 10,000 acres of airport grounds in the northeastern Great Lakes and middle Atlantic states. Eventually, all major U.S. Airports will receive such treatment.

(Oil Paint and Drug Reporter, May 8 1961, *179* (19), 37).

In Europe, the chafer attacks more than sixty different fruits, vegetables, field crops, ornamental plants and trees. England reports losses amounting to $280 per acre to crops of orchards in a single season under outbreak conditions USDA reports that larvae have caused up to 65% loss of peas and beans on English farms.

2. **Dissemination of Granules by Air:** Experiments to improve conventional application (hopper/airscoop system) are reported. Initial tests were carried out with an airfoil attachment installed beneath the fuselage of a high-wing plane and under the wing of a low-wing plane. Use of the airfoil created little drag on the forward motion of the plane and resulted in even distribution of granules. As the granules were released further from the centre of the airfoil, the swath made by the fallen particles became wider. But releasing granules from the ends of the airfoil produced a swath of only 28 to 30 feet. To determine whether the use of a longer winglike distributor could produce a wider swath and provide even distribution and little drag, granules were released from small hoppers mounted on the wing. Best results were obtained by releasing granules about 9 feet from the centre of the plane. At this point, the granules were spread evenly in a swath 40 to 45 feet wide.

(Agricultural Research, May 1961, *9*, (11).)

3. **Lygus Bug *(Lygus hesperus)* Control:** Recent trials are reported which indicate that "Dylox" plus DDT at one pound active of each per acre - is especially effective for lygus control on table beet and carrot seed crops. Other chemicals with "Dylox" controlled the bugs satisfactorily, but were considerably more toxic to beneficial predators and pollinators .

"Dylox" alone shows promise for bug control on vegetable seed crops and is considerably less toxic than most phosphate insecticides to beneficial insects and to humans and animals.

(California Agriculture, April 1961, *15*, (4).)

4. New Insecticide Combination: 2% Dibrom/Dri-Die 67: A small amount - 2% - of the active insecticide "Dibrom" blended with the sorptive dust "Dri-Die 67" produced a fast-acting and long-lasting insecticide.

In laboratory experiments the mixture knocked down German and brown-banded cockroaches 9-12 times faster than "Drie-Die 67" alone. Oriental cockroaches were knocked down 18 times faster and American cockroaches 23 times faster.

Cricket infestations around commercial establishments have been controlled by applying the dust to sidewalks, particularly next to building frontages, and on window and door frames and sills at the rate of ¾-1lb. per 1,000 sq. ft. of floor ground area. When killed with sorptive dusts, crickets lose body fluids so rapidly that their bodies do not undergo the decomposition which ordinarily causes offensive odours.

It has also been used with success against bedbugs and fleas in infested premises and against fleas on dogs and cats.

(California Agriculture, May 1961, *15*, (5).)

5. Sevin as Blossom Thinner: In more than 100 tests at Wenatchee, Wash., and New South Wales, Australia, "Sevin" was consistently effective in thinning 5 major varieties - hard-to-thin Golden Delicious and Jonathan and easily thinned Delicious, Winesap, and Granny Smith. The concentrations on Delicious ranged from ¾ to 1½ lb per 100 gal water and on the other varieties from 1½ to 3 lb per 100 gal. The time of application was between 15 and 25 days after full bloom.

The blossom-thinning property of "Sevin" was first observed in 1958, when the chemical was tested against the codling moth in central Washington. Applied at the rate of 1½ lb per 100 gal of water at first cover stage (15 to 20 days after full bloom), "Sevin" not only controlled the moth but also reduced fruit set of Delicious and Winesap apples.

(Agricultural Research, May 1961, *9*, (11).)

6. Southern Forest Pest Control: Use of Systemics: Phorate (one of whose trade names is "Thimet", used as a systemic, continues to control the cottonwood twig horer, *Gypsonoma haimbachiana*. Several plantings with and without the chemical were made by co-operators in 1960. In a commercial plantation near St. Francisville, Louisiana, for example, one-year-old trees from cuttings dipped in phorate averaged 12.0 ft in height, in contrast to 10.7 ft for trees from untreated cuttings. Treated trees averaged less than one twig borer per 20-inch terminal while untreated trees had more than three per terminal. Injury or death of terminal buds was four times greater in the untreated trees.

Preliminary studies at Gulfport, Mississippi, indicate that a year's protection from the Nantucket tip moth, *Rhyacionia frustrana*, can be obtained by applying 10 g phorate around the base of each one-year-old loblolly pine. Granular phorate was applied in late winter before the trees started their growth. All treated trees remained free of tip moth throughout the year, while nearby untreated trees sustained heavy attacks. Trees were about 1.5 ft tall at the beginning of the growing season, but at the end those treated with phorate averaged more than a foot taller than the untreated checks.

Phorate has a high mammalian toxicity and should not be used unless proper precautionary measures are taken. Because of this and the preliminary nature of the test, no recommendations are made at the present time for wide-scale use of the systemic for tip-moth control.

(Southern Forest Experiment Station (Forest Service, U.S. Dept.of Agric.)
Report for 1960, published 1961.)

7. Termite Control

a) Soil Treatment: Several chemicals suggested for soil treatment to keep subterranean termites out of buildings are still giving excellent results in field tests, In Mississippi, 100% protection has been obtained with 0.5% aldrin and 0.5% dieldrin for 11 years and with 1% chlordane for 12 yrs. Heptachlor, recently suggested for use at a 0.5% concentration, has given 100% protection for 8 yrs.

There are good indications that the service of these insecticides would be lengthened considerably in use under buildings. For example, DDT applied at 8% in field tests in Mississippi gave only 10% protection against termites after 14 yrs, whereas 5% DDT applied under buildings at Fort Bragg, North Carolina, has given 97% protection for 14 yrs.

b) Combined Wood Preservatives: In cooperation with the U.S. Navy, Bureau of Yards and Docks, studies were begun in 1959 to determine the value of adding various insecticides to two wood preservatives (against decay fungi) to prevent termite attack. Formulations of 2% chlordane, 1% dieldrin, 1% aldrin, or 1% heptachlor were combined with 5% pentachlorophenol and 2% copper napthenate. Some formulations also include water repellents. All formulations were applied as 3-minute soaks.

Results after approximately one year indicate that combinations of any of the above insecticides with pentachlorophenol are superior to pentachlorophenol alone in preventing termite attack. The addition of a water repellent had no appreciable effect against termites. All formulations containing 2% copper naphthenate have thus far prevented termite attack; hence the value of adding the insecticides to this preservative cannot yet be ascertained.

(Southern Forest Experiment Station, (Forest Service, U.S. Dept. of Agric.), Report for 1960, published 1961.)

8. Research at American Universities, University of Florida

a) Insecticide Residues: Study of Climatic Effects: A single application of 5% DDT dust was put on Shogoin turnips at 2 rates of 43.5 and 59.8 lb per acre. Immediately after treatment specially constructed cages, designed to study the effects of certain climatic factors, were placed over plants in the treated areas. Foliage samples taken 2 hrs, 7, 14, and 21 days after treatment were analyzed chemically for insecticide residues. There was considerable fluctuation in the amount of residue found in samples from similar cages at different sampling periods. This indicates that climatic factors had less influence on the amounts of insecticide residue found at any given time than sampling methods or other factors as yet undetermined.

b) Bee Repellent: Compound R-874, an insect repellent developed by Phillips 66 Petroleum Company, has been reported to protect honeybees from toxic pesticides used in agricultural sprays. When sprayed on cantaloupes at the rates of 5, 10 and 15 oz in 100 gal of water per acre, this material effectively kept bees out of the field during the days on which it was applied. The yield of cantaloupes was not affected.

This same material was applied to a blooming pineapple orange grove at the rate of 10 oz in 500 gal water per acre to determine its effectiveness on citrus. Early counts showed that it was repelling bees to some extent, but rising winds caused all bee activity to stop before conclusive results could be obtained.

c) Insecticide Screening:

Tobacco Pests: Sevin dust and a spray containing SD4402 gave excellent control of budworms and hornworms. Dimethoate and "Dylox" also gave good control of hornworms but were less effective against budworms.

Fruit and Nut Insects: Sprays of dimethoate, "Trithion", parathion and "Oilan" (malathion plus petroleum oils), applied to peaches, all gave good control of white peach scale and fair control of the plum curculio.

"Sevin", "EPN" and "Guthion" sprays were about equally effective against the hickory shuckworm on pecan and all gave fair to good control on both Mahan and Moore varieties. Parathion applied with a hydraulic sprayer, a high velocity mist blower, and by helicopter gave fair to good control of nut casebearer with little difference attributable to method of application.

Corn Earworm on Sweet Corn: Two dusts and 6 sprays were used in the spring of 1960. The initial application was delayed 2 days by rain and high wind and the rather poor results are attributed to this. 10% dusts of "Sevin" and DDT and "Sevin" spray at 1.5 lb per acre were the most effective treatments and gave 78.8, 70.3 and 71.2% worm-free ears respectively.

(Annual Report of Agricultural Experiment Stations, for the Fiscal year ending June 30, 1960. University of Florida Gainsville, Florida).

INDIA

Coconut Pests.

Oryctes rhinocerus L: A general survey of the pest population in relation to ecological conditions was carried out. Insecticidal trials were continued in the laboratory with lindane, heptachlor and chlordane to assess the immediate and residual toxicity when mixed with the breeding material of the beetle. Field experiments for the control of the beetle were continued. (1) by providing trap pits and (2) by leaf axil filling with insecticides. In the trap pit experiment the percentage of fresh incidence of beetle attack was 0.53-3.2 in the treated plot and 3.3-11.4 in the control plot. The leaf axil filling experiment with BHC and chlordane in combination with various diluents was concluded. Results indicate that of the different treatments BHC plus saw-dust is the most effective in controlling the pest. Experiments to determine the prophylactic effect of BHC, chlordane, aldrin and heptachlor when introduced into the leaf axils was started during this year. Studies with exotic and indigenous parasites and predators were continued.

Intensive propaganda on a campaign basis was carried out in Mysore against the rhinoceros beetle and treatment of manure heaps and compost pits with 5% BHC was recommended and carried out to prevent breeding of the pest.

Nephantis serinopa Meyr: Insecticidal trials were carried out with dieldrin and malathion in the laboratory as well as in the field.

Biological Control: The common parasites of the pest are *Perisierola nephantidis, Elasmus nephantidis, Brachymeria nephantidis, Trichospilus pupivora, Xanthopimpla punctata* and *Goryphus nursei. Bracon brevicornis* was of rare occurrence. The parasites were bred in the laboratory in large numbers. A total of 68,540 Bethylids, 80,000 Braconids, 2,400 Elasmids and 543,000 Eulophids were supplied to the parasite breeding stations and for liberation in pest infested gardens. Several thousands of *Aprostocetus israeli* were bred in the laboratory and were regularly liberated in a selected coconut garden.

Rhynchophorus ferrugineus F: Insecticidal trials were continued in the laboratory as well as in the field. "Pyrocon E 2/20" at 1% concentration was effective in controlling weevil attack. Experiment to study the prophylactic effect of BHC/chlordane placed within the leaf axis were continued. Search for parasites was carried out.

Leucopholis coneophora Burm: Studies on the biology of the beetle continued. Insecticidal trials conducted in the field with BHC, chlordane, heptachlor, aldrin, dieldrin and malathion showed reduction in the pest attack in the treated plots as compared to the control.

(The 15th Annual Report of the Indian Central Coconut Committee 1st April, 1959 to 31st March, 1960).

Coffee Pest Research

White Stem Borer *(Xylotrechus quadripes):* 'Dieldrex 18' E.C. (at 0.25% a.c.) when applied twice per year gave the lowest figure of borer incidence while 'Dieldrex' (at 0.125% a.c.), dieldrin 50% W.P. (at 0.25% a.c.) and BHC 50% W.P. (at 1.0% a.c.) each applied thrice, showed degrees of effectiveness in descending order.

Green Bug *(Coccus viridis):* 'Gusathion' (0.05%) has a prolonged duration of toxicity while 'Folidol' (0.01%) remains equally effective only until 15 days after treatment.

'Fosferno', 'Paramar' and 'Meta-iso-systox' show comparable potencies at 15 days and 25 days after treatment at 0.03%, 0.05% and 0.05% respectively.

Root Mealy Bug *(Pseudococcus citri):* At 8 and 48 hours after treatment, 'Basudin' was consistently superior to the rest to bring the highest degree of mortality. Also, the effectiveness of 'Folidol' and 'Gusathion' (8 hours after treatment) favourably compared with that of 'Basudin'. At 48 hours after treatment, however, 'Ekatin', 'Paramar' and 'Folidol' showed degrees of toxicity comparable to 'Basudin'.

Shot Hole Borer *(Xyleborus morstatti):* Earlier experiments with 'Metasystox' and 'Ekatin' by the 'banding method' failed to give significant reduction in pest incidence. To study the effect of the chemicals - sprayed on the foliage - on pest incidence, a small-scale exploratory field trial was undertaken at the Coffee Research Station. The concentrations of the chemicals tried were:

(a) 'Meta-iso-systox' 25% E.C. (0.1% a.c.) and
(b) 'Ekatin' 20% E.C. (0.04% a.c.)

The above systemics have shown some degree of promise, and extended field trials using a series of equitoxic concentrations are to be started at the Coffee Research Station, and in a few liaison zones as soon as the pest species regains activity.

Hairy Caterpillar *(Eupterote fabia):* In October 1958, a mass scale spray operation with 'Folidol' (0.01% a.c.), BHC (0.25% a.c.) and DDT (0.15% a.c.) was adopted at Chikli Estate, Chikmagulur, to control the IV and V instar caterpillars found on dadaps 30' tall. Observations, the day following treatments, showed that the chemicals effected appreciable control of the species and a majority of the treated plants bore dead and paralysed caterpillars. The success of this operation was so encouraging that the programme of spraying on the shade was undertaken and continued by several planters in the area. This in its wake, during the 1958-59 season, considerably minimized the extent of damage done to coffee by the migrating and advanced caterpillars in October-January. Based on the above, a schedule of operations has been established for the forthcoming seasons. The utility of applying mist and fog through a "swing-fog" to control the caterpillars on various levels of shade is to be assessed in the oncoming season.

(Twelfth Annual Report of the Research Department of the Coffee Board, 1958-1959.)

Tea Pests Research

Red Spider *(Oligonychus coffeae):* From the results of laboratory trials conducted with various acaricides against eggs and active forms of red spider, the following conclusions can be drawn:

As ovicide:

1. 'Tedion' and malathion are highly effective.
2. 'Akar' is as effective as malathion but inferior to 'Tedion'
3. 'Kelthane' (1:500) is moderately effective but 'Kelthane' (1:800) and lime sulphur are not found to be satisfactory.

Against active forms:

4. 'Kelthane (1:500), malathion and lime sulphur are highly effective.

5. 'Tedion' has a moderate effect on active forms. ('Akar' was not included in the trials against active forms).

Looper Caterpillar *(Biston suppressaria):* A field trial was carried out in a neighbouring estate, with two concentrations of 'Aldrex 30' E.C. and one concentration of 'Endrex 20' E.C. against almost full-grown looper caterpillars using 80 gallons of spray per acre (909 litres per hectare) applied by means of low volume sprayers. There were 25 bushes in each plot. The efficacy of these pesticides was assessed from the unaffected looper population present on bushes at 48 hours and 96 hours after treatment. 'Endrex' proved to be highly effective against looper, while the reduction obtained with 'Aldrex' at both concentrations at 48 hours after treatment is not satisfactory, though superior to the control. At 96 hours, 'Aldrex' did not show significant reduction over control and this might be due to the pupation of a large number of looper in control plots.

Green Caterpillar *(Rhesala moestalis):* A field trial was carried out with 'Endrex', 'Dieldrex', lindane, malathion, DDT and BHC in order to ascertain relative efficacy of these pesticides against green caterpillar, a serious pest of nursery and young shade plants. Ten plants were examined for unaffected caterpillars from each treatments, 48 hours after treatment. The results show that all the pesticides are highly effective, there being no significant difference amongst them. As the eggs virtually remain unaffected, a second application is necessary to control the pest in existing infestation.

(G.M. Das. Tocklai Experimental Station, Annual Report 1959.)

Tobacco Pest Control

Rajahmundry: The insecticides DDT, "Rhothane" and "Endrex" were equally effective in controlling cutworms damaging seedlings. Dieldrin, chlordane and heptachlor proved effective against groundnut beetles (*Mesomorphus* spp.) "Folidol" and "Basudin" gave 94% control against aphids followed by malathion which gave 69% control. From 3 years' experiments it was evident that "Eolidol" and "Basudin" at 20 oz per acre were most effective against aphids.

Bidi, Anand: From the results of the experiments conducted in the past and taking into consideration the economics, it was concluded that for the control of stem-borer in bidi tobacco, spraying with endrin 0.01% at an interval of 15 days after transplanting could be recommended. Endrin 1% dust was better than DDT 5% dust and dieldrin 1.5% dust in controlling leaf-eating caterpillars. Dieldrin 1.5% dust at the rate of 16.5 lb per acre is the cheapest, followed by DDT 5% dust and endrin 1% dust.

(Indian Central Tobacco Committee. Fifteenth Annual Report 1959-60.)

MALAYA

Agricultural Pest Control

Rice Stem Borer: An insecticidal control experiment using DDT in the 1958/59 season gave disappointing results. A trial to determine the effectiveness of 'Rogor 40', 'Basudin', 'Dipterex' and 'Oleolindrine' against stem borers when applied about four weeks before flowering was carried out at a number of sites. This trial is still in progress. A further pot experiment is in progress to compare the effectiveness of endrin, dieldrin, 'Rogor 40', DDT, BHC, diazinon and malathion against stem borers. This indicates endrin-control to be associated with significantly increased yields while malathion and DDT are not. The use of endrin in Malaya is, however, restricted by law because of its toxicity to mammals. On the advice of the Japanese Colombo Plan Entomologist, 'Dipterex' was tested in a pot trial. This trial indicated that there was a possibility of controlling young stem borers with this insecticide although older ones are less susceptible.

Coconut, *Oryctes spp.*: Laboratory tests were carried out to discover the most effective insecticide for controlling *Oryctes* grubs. Five insecticides were used on half to full grown grubs in sawdust and the following encouraging results were obtained. The percentage kill was recorded after 9 days.

(a)	Malathion	0.5% a.i.	58.3%	&	83.3%
(b)	Basudin	0.5% a.i.	91.7%	&	100%
(c)	Endrex	0.5% a.i.	91.7%	&	100%
(d)	Oleolindrine	0.5% a.i.	91.7%	&	100%
(e)	BHC w.p.	0.5% a.i.	–		100%
(f)	Control	0	–		8.3%

Cacao, *Helopeltis*: Five tests have been carried out with the object of finding out the most efficient and economic method of controlling *Helopeltis* attacking cacao. Three of the tests were conducted at the Federal Experiment Station, Serdang, and two at Kampong Awah, Pahang. General conclusions drawn from this experiment are as follows:

(1) No differences in the efficiency of the various insecticides used were detected.

(2) Evaluation on an experimental scale of individual insecticides is rendered very difficult due to the mobility of the insect, *Helopeltis theobromae*, allowing only overall intensity of infestation to be estimated thus masking the effectiveness of individual insecticidal treatments.

(3) After 5 applications of insecticide, attack recurred after 4 to 5 months whereas after only 2 applications attack recurred after 2 months.

(4) 'Motoblo' spraying controlled the pest for 22 weeks whereas fogging controlled the attack for only 8 weeks.

Pineapple, Mealy Bug: An experiment started in 1958, to determine whether mealy bug wilt is caused by the feeding and saliva of mealy bugs or by a virus transmitted by the mealy bug, was completed during the year. The results were inconclusive.

General: Help in the control of outbreaks of pests is one of the extension services of the Field Branch and in most states specialist gangs are available to give assistance when required. These gangs are equipped with sprayers, dusters and in most States fogging appliances; rat poisons and insecticides are also available for distribution to smallholders. While this arrangement is desirable at present, the ultimate objective of the existing activities in this direction is to educate the farmers to be able to identify important pests and to know how to control them.

(Annual Report of the Department of Agriculture for the Year 1959.)

NEW ZEALAND

Dieldrin and Aldrin Resistance on Green Blowfly: For several years dieldrin and aldrin have been widely used in New Zealand for the control of keds, lice, and blowflies on sheep. These modern insecticides, because of their outstanding persistence in the fleece, remain active many weeks after application. A further advantage is their ability to spread through the fleece, so that complete saturation has not been necessary and good control has followed surface application as a tip spray or as a dust.

Over the past two seasons, however, the green blowfly has developed resistance to dieldrin and aldrin, particularly in Marlborough, Nelson, Hawke's Bay, and Poverty Bay. Several years ago Australia and South Africa had a similar experience with *Lucilia cuprina*, a close relative of the New Zealand fly, *Lucilia sericata*. In those countries resistance became widespread in a short time and the use of alternative insecticides became essential to control fly strike.

Comparisons of Susceptibility to Dieldrin: In experimental work at Wallaceville, comparisons have been made of the susceptibility of several strains of flies to dieldrin. The methods used involved applying measured drops of various strengths of insecticide to the bodies of adult flies and noting the mortality rate after 24 hours.

It has been shown that the dose of dieldrin required to kill the most resistant strain is about 400 times the dose required to kill normal susceptible flies.

All resistant strains so far tested have proved to be fully susceptible to diazinon. The use of an organophosphorus insecticide, such as diazinon, "Delnav", or nankor, is therefore indicated where dieldrin and aldrin resistance is present or suspected.

(New Zealand Journal of Agriculture, April, 1961, *102* (4).)

Dogs Susceptible to Dieldrin: Over the last few years a considerable number of cases of suspected dieldrin poisoning in sheep dogs has been diagnosed and new cases are still occurring. Dogs are known to be very susceptible to this type of insecticide, and experimental work has shown that putting them through normal strength dips is enough to kill some dogs. Dieldrin is a cumulative poison and can be taken into the system by swallowing the dip or by absorption through the skin. It is therefore very important to keep the exposure of dogs to dieldrin type dips, sprays, or dusts to the minimum.

(New Zealand Journal of Agriculture, March 1961, *102*, (3).)

WEST AFRICA (GHANA)

Cocoa, Capsid Control: The endrin and "Sevin" joint WACRI/Division of Agriculture trials at Kwahu Tafo have been terminated having given evidence that endrin sprayed 3 times per year, November, March and July, at 1 oz actual toxicant per acre will give very effective control of capsids on 2 acre plots. Results with "Sevin" at 1½ lb actual toxicant per acre are disappointing. If costs of the insecticide become more economic, however, it is possible that a double application would result in a satisfactory control of capsids. These two insecticides have been replaced by 'Dipterex' and 'Bayer S.1752' which will be applied as a double spray with one month's interval.

Cocoa, Ant Mealybug Control: Surveys of *Marmara* gave evidence of a very high incidence of *Marmara* damage on pods in both treated and untreated plots. Further damage by *Eulophonotus* larvae has occurred on all treated plots and it has become evident that the expectation of the experiment, which was to minimise adverse secondary effects of heavy dosages of dieldrin by different methods of application and formulation, is not being fulfilled. Further work on potential formicides will now be followed using heptachlor and chlordane.

Cocoa, Shot-Hole Borer Control: Eight treatments, replicated nine times have been arranged as follows:

1) 0.5% dieldrin

2) 1.0% dieldrin with added coumarone resin

3) 1.25% DDT

4) 1.0% endrin

5) 1.0% 'Sevin' (1-naphthyl N-methylcarbamate)

6) 2.0% 'Sevin'

7) Unsprayed control

8) Unsprayed control

Treatments 1 to 4 inclusive, employ emulsifiable concentrates whilst treatments 5 and 6 are with an 85% wettable powder. Spraying is being done at monthly intervals with pressure-retaining knapsack machines, and the stems of the seedlings are thoroughly wetted. The first spray was applied early in November.

(West African Cocoa Research Institute. Quarterly Progress Report No.60. October-December, 1960)

WEST AFRICA (NIGERIA - NORTHERN)

Cotton Insecticide Trials

Samaru: In a date-of-sowing trial there were 4 replications of 20 plots, each 3 x 12 yards, sown serially with cotton at intervals of 4 days over a period extending from mid-June to the end of August. On 2 replications, sowings up to mid-July were sprayed at weekly intervals from 21st August to 20th November, the later sown plots being included in the spraying programme as the plants became about 12 inches high. The spray consisted of a mixture of DDT and gamma BHC applied at the rate of 2 lb and 0.6 lb per acre respectively. Germination of some of the earliest sown plots was irregular owing to lack of rain, and growth over the whole experiment was poor. Analysis of the final yields, table below, showed that sowing date had an extremely marked effect on yield, whether insecticide was applied or not. Yield increases of a similar order were obtained in a trial comparing the the effect of endrin with that of DDT/BHC. Five applications of insecticide were made at weekly intervals from 6th October to 2nd November, on cotton sown on 12th July.

The occurrence of plants with distorted roots was noted in the Annual Report for 1955-56. This year it was found that the addition of 0.5 g of 'Agrocide 3' (containing 0.65% gamma BHC) to the planting holes of raw 26C had no effect on the percentage of damaged roots. In this experiment the cotton was planted on 9th July, and about four-fifths of the plants in treated and untreated plots had normal roots when uprooted in November. The insecticide had no effect on germination, plant height or on the incidence of bacterial blight.

Serial Sowing date of Cotton, With and Without Application of Insecticide, Samaru, 1956-57.

Sowing Date	Yields of Seed Cotton in lb per acre		
	Unsprayed	Sprayed	Difference
15th June to 30th June	277	391	114
1st July to 15th July	252	438	186
16th July to 31st July	248	319	71
1st August to 15th August	87	182	95
16th August to 31st August	13	31	18

Kontagora: Following on the experiments carried out at this station during the past two years, it was shown that a series of four sprays based on DDT and gamma BHC, applied during September and early October gave higher yields than a similar series of sprays applied during October and early November.

Mokwa: The relatively small increases in yield obtained at Samaru are in marked contrast to the results obtained at Mokwa. At Mokwa the cotton stainer is largely responsible for the low yields and poor quality of cotton obtained. During 1956 two generations of adults followed the initial invasion into the crop during September and early October.

In a date-of-sowing trial, which included cotton sown at 3-day intervals from June to September, the earliest sown plots were sprayed at 2-week intervals from 31st July to 20th November, with additional applications during October. Later sown plots were included in the spraying programme as they became about 12 inches high. The mixture consisted of DDT and gamma BHC applied at rates of 2.4 lb and 0.7 lb per acre respectively.

The height of the June sown cotton averaged about 5 feet, more than twice that of July sown cotton. Good control of stainers was achieved in the sprayed blocks and little breeding occurred. Examination during October of cotton sown during June showed that the sprayed plots carried 55% more bolls than the unsprayed plots, and that the number of bolls with internal stainer damage was reduced from 65% to 38%.

(Annual Report of the Ministry of the Northern Region of Nigeria for the Year 1956-57.)

Tsetse Control

Komadugu Gana Flood Plain: Reclamation of the area started in 1956. *Glossina morsitans* is the chief vector. *G. tachinoides* is present in the riverine vegetation. The insecticide used is DDT wettable powder applied once during the dry season. Initially, the insecticide was applied at a strength of 5% DDT w.p. in aqueous suspension. Later, this was reduced to 3.75% and this concentration was found to be sufficient.

At first it was thought necessary to insure against re-invasion during the wet season by relying upon natural or artificially cleared barriers. Subsequent investigations showed that very little invasion did in fact take place and that it is much more economic to respray the reinfested area during the following season than to clear expensive barriers.

Spraying of vegetation becomes more selective as the season progresses, until finally it is found that spraying of tree trunks over about eight inches in diameter and up to a height of about five feet is sufficient to eradicate *G. morsitans*. Only trunks inside thickets or in shade are sprayed. Leaves, branches and shrubs are ignored.

The lower part of the heavier riverine bush is sprayed against *G. tachinoides*.

Mayo Mbulo Flood Plains: This tributary of the Mayo Ine again harbours *G. tachinoides* along its banks, also in the scattered clump thickets found in the flood plains.

Eradication of fly in this locality was effected by applying, to the vegetation, 2% dieldrin by means of "Swingfog" fogging machines and "Micronette" sprayers. Three applications were made at 14-day intervals.

G. tachinoides has been eliminated from an area of over 60 sq. miles.

Gongola Valley: A fairly large, isolated focus of *G. tachinoides* in an area which is otherwise clear of tsetse, occurs near Falu. Three applications of 2% dieldrin were made at 14-day intervals by means of Swingfog machines. For a period of three months after completion of fogging operations all fly rounds in the area produced negative results, after which isolated flies were being caught. The situation is being investigated.

The Dong concentration of forest islands which were fogged with 2% BHC over 12 months ago are still free from *G. tachinoides*. The cattle population in this locality is increasing.

Control of Ecto-Parasites.

Spraying with knapsack sprayers or force pumps for the control of ticks has become increasingly popular. The skin disease of economic importance is streptothricosis and up to 25% of hides were infected at Kano abattoir during the rainy season, falling to 5% during the dry season. Ticks are usually associated with the incidence of this disease, especially *Amblyomma variegatum*, but in Bornu a definite relationship was established between the prevalence of swarms of *Lyperosia* flies and the occurrence of streptothrix infections. Control of *Lyperosia* with "Gammatox" sprays reduced the incidence of the disease.

(Annual Report on the Veterinary Division of the Ministry of Animal Health and Forestry of the Northern Region of Nigeria for the year 1957-58.)

WESTERN SAMOA

Coconut

Rhinoceros Beetle: The regular treatment of palms in the port area continued throughout the year. A certain proportion of the time of the crown treatment gang was spent in field sanitation work on the ground. In the course of these activities 26,652 beetles were destroyed in the year. The number of palms climbed in the year was 15,828.

The insecticide used in the crown treatment work was BHC, which was mixed with sawdust. This method of treatment has now been used for a number of years, and has proved very effective.

A predator on Rhinoceros beetle larvae, *Neochryopus savagei*, was introduced into Samoa during the year. Approximately 1,000, which had been collected under the auspices of the South Pacific Commission, were released at various points in Upolu, stretching from Leauva'a to Solosolo, and also at Samatau.

The predatory beetle is very powerful in attacking its prey and although it does not limit its activities to the larvae of *Oryctes* it is hoped that it will have a good effect in controlling the pest, should it successfully establish itself in Samoa.

Tests with "Insectocutor": An instrument known as an insectocutor was obtained early in the year. It consists of an electrified panel to which insects are attracted by means of ultra violet lights. The insects are killed, or in the case of larger insects, stunned when they touch the panel. It proved very effective in attracting and killing a wide range of night-flying insects. A certain number of Rhinoceros beetles came to the light, but it is uncertain whether the instrument has a significant effect in attracting them. The apparatus was tried out in a number of different localities, with similar results in each.

Banana

Scab Moth: In May a consignment was received from Fiji of pupae and mated females of the *Chelonus* wasp, which parasitises the scab moth. Subsequently breeding was carried out in the insectary at Nafanua, and many wasps were liberated at two banana plantations, one at Papauta and the other at Toamua.

(Territory of Western Samoa, Department of Agriculture, Forests, and Fisheries, Annual Report for 1960,.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

ADEN

Malaria: The policy laid down in general is eradication from east to west and south to north, the procedure being application twice yearly (to be altered to 3 monthly) of BHC 50% isomer to all localities in which anophelism exists, and aquatic control in such places within one mile of all habitations.

During the year, breaks in continuity of service of senior staff have no doubt set things back to some extent but apart from this the fact remains that the time is ripe in each Protectorate for a Senior Public Health Inspector, Arabic speaking and able to apply drive and persistence beyond the abilities of the doctors who are thin on the ground and largely tied to developing hospitals. In view of the recommendations of WHO (1960), it seems also advisable to spray BHC at intervals of 3 months, not 6, which will double the cost in BHC. Help continues to be sought from C.D.W. funds for the appointment of the Public Health Inspectors and special funds from the same source for more materials for the eradication of malaria.

In spite of the accretion of figures for malaria cases from Lahej and Tarim Hospitals, the proportion of these to all cases shows no great rise.

(Annual Report on the Aden Protectorate Health Service for the Year 1951).

BARBADOS

Aedes aegypti: WHO/UNICEF Eradication Programme: The programme continued throughout the period under review with unabated intensity. Results have been satisfactory. Many of the difficulties which presented themselves during the latter part of the previous year, were again prominent. Whereas improvements were noted in many of the areas, there were other areas where progress had been retarded to some extent by the truculent and non-co-operative attitude adopted by householders. The 'closed house' problem is being tackled with some measure of success but here again, on some of the premises where inspection and treatment has been possible, the householders at times sought to dictate to the inspector the 'modus operandi' on their terms. The evil, attendant on such attitudes, can be easily appreciated when it is known that the householders in most cases belong to the better privileged class. Despite these and other handicaps experienced throughout the period, much progress has been recorded both in the Northern and Southern Areas where many of the localities have been returning negative results on more than one occasion in the former area; while in the latter, the incidence of breeding has been reduced to a comparatively low level.

The units had been re-organised at the time of writing and it is proposed that during the 1958 programme, a further re-organisation scheme will be put into effect and which it is hoped will lead to ultimate eradication before the end of the fourth quarter of the year.

(Director of Medical Services. Annual Report for the year 1957-58.)

EAST AFRICA

Medical Research: A meeting of the East African Medical Research Scientific Advisory Committee was held on the 11th and 12th January, 1960. The East African Council for Medical Research met at Entebbe on 5th February, 1960. Mr. E.B. David, C.M.G. Administrator was present as *ex officio* Chairman for the first time. Professors Woodruff and Macdonald were members of both bodies appointed by the Colonial Medical Research Committee, Dr. Lewthwaithe again attended as the nominee of the Secretary of State for the Colonies. At the Council meeting the Permanent Secretaries for Health attended for the first time though only Dr. Davies of Uganda did so in his own capacity, the others represented their absent Ministers as members. The Director of Medical Services, Zanzibar, represented the Chief Secretary.

The Committee considered the estimates and research programmes of the Research Institutes* and the Leprosy Research Centre and the Council approved their recommendations. It was announced that although the East African territories had agreed to a five-year budget for the Agricultural and Fisheries Research Council no similar undertaking could be obtained for medical research.

(The East African Council for Medical Research, Annual Report, 1959/60.)

GAMBIA

Malaria: Different species of the anopheline mosquito which transmit malaria breed in fresh water and in brackish water in the Gambia. In Bathurst it seems likely that the land reclamation schemes and drainage programme of recent years have considerably altered the picture of transmission by reducing the number of mosquitoes which breed all the year round in brackish water, and increasing the proportion of mosquitoes which breed principally during the rains in fresh water. The incidence of morbidity and mortality from malaria in Bathurst differs, therefore, from that in the neighbourhood, which also differs from other parts of the country where conditions are dissimilar.

Over the country as a whole, malaria is holo-endemic. The infant is born with an immunity transmitted from the mother. In the latter half of the first year of life this immunity wanes and the infant begins to suffer clinical attacks of malaria of increasing severity. From then until the third year, malaria is a serious disease, with a heavy mortality. Thereafter, in response to constant re-infection, immunity increases, and clinical attacks decrease in severity, until in adult life malaria is no longer a significant cause of mortality. In the Gambia, therefore, although malaria is widespread, it is not a disease of great economic importance, nor is it a major problem of public health except in young children, in whom immunity is purchased at a high cost of lives. This is similar to what is known of malaria elsewhere in West Africa, but is quite different to the classical concept of malaria, derived from experience in the East, where it is an unstable epidemic disease with high adult mortality and is a major economic burden on the community.

Because of the special features mentioned above, and the limited funds available, malaria control is restricted to Bathurst and its immediate neighbourhood, including the international airport at Yundum. In 1959 control in Bathurst was improved by pumping sea-water through the increasing number of permanent open concrete drains, in which mosquito breeding takes place, and thus flushing them out. In 1959, also, area fogging was introduced, using special insecticidal fogging equipment.

Yellow Fever: No case of yellow fever has been reported since the outbreak in Bathurst in 1934. A survey carried out in 1955 showed that in the greater part of the Protectorate there was a high level of immunity to yellow fever, but no clinical evidence of the disease. This was interpreted at the time as meaning that the people were constantly exposed to yellow fever, and developed an immunity, as in the case of malaria, but without the associated infant mortality. However, work at present being carried out at the laboratories of the West African Council for Medical Research at Yaba, Nigeria, tends to show that the immunity to yellow fever virus in West Africa can arise in response to infection with other related viruses of low pathogenicity to man. It has been shown in the laboratory that infection with certain recently-discovered viruses will produce immunity to subsequent infection with yellow fever virus, due to cross-immunity. This is similar to the well-known immunity produced by the comparatively harmless cow-pox (vaccinia) against the far more dangerous disease of smallpox, which forms the basis of the procedure of vaccination against the latter. The difference is that immunity to yellow fever is produced naturally in areas where suitable viruses exist whereas immunity to smallpox is produced by artificial means. Work proceeding elsewhere upon virus infections of West Africa may have great future importance for the Gambia.

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* E. African Institute of Malaria and Vector-borne Diseases; E. African Institute for Medical Research; East African Virus Research Institute; E. African Trypanosomiasis Research Organization.

(Gambia Report for the Years 1958 and 1959, London H.M.S.O., 1961)

HONG KONG

Pest Control (Agriculture): The Crop Pest and Disease Control Service gave assistance to 119 farmers and visited 30 villages to render both assistance and instruction. A total area of 1,094.4 dau chung* including 988.9 dau chung of paddy, 16.5 dau chung of vegetable and 99 dau chung of miscellaneous crops were sprayed. This represents a marked decrease in the work carried out in the previous year and was occasioned by the implementation of policy whereby farmers, particularly market gardeners, were encouraged to own and use their own sprayers and insecticides. The Kadoorie Agricultural Aid Association gave this policy great stimulus during the year by the free distribution of some 4,621 sprayers to deserving farmers, including members of Co-operative Societies. Farmers also obtained loans from the Kadoorie Agricultural Aid Loan Fund for the purchase of sprayers and/or insecticides.

Forest Pest: The defoliating caterpillar *(Dendrolimus spectabilis)* occurred in many stands of local pine throughout the Colony. Pilot trials with various spraying equipment were carried out and in the light of experience more adequate and up to date equipment was ordered. Although attacks of these insects did not kill trees, the latter were noticeably retarded in both vigour and growth.

In a comparative trial, using eight different insecticides for the control of pine caterpillar *(Dendrolimus spectabilis)* "Agrocide 26" dispersible powder gave complete control at a cost of $12.30ø per acre.

Other Pests: It was found that stink bug *(Tessaratoma papillosa)* could be controlled on lychee at a cost of $3.31 per tree to protect and save 100 lb. of fruit valued at approximately $50; where rice stem borer *(Schoenobius incertellus)* occurred treatment with "Endrex" showed a nett increase of $63 an acre.

(Hong Kong Annual Departmental Report, By the Director of Agriculture, Fisheries and Forestry, for the financial year 1959-60).

KENYA

COFFEE SERVICES *(T G Crowe)*

Leaf Miner *(Leucoptera spp):* Following the discovery that the common organo-phosphorus insecticides are ovicidal, revised recommendations were made for leaf miner control; parathion, methyl parathion and diazinon were the chemicals most used by planters. Experiments at the Pyrethrum Board of Kenya's laboratories showed that pyrethrum sprays are ovicidal at concentrations as low as 0.001% pyrethrins.

Antestia *(Antestiopsis lineaticollis* Stal.): Attacks were not outstandingly severe during 1959. This appeared to be partly due to extensive spraying against leaf miner and, partly to high percentage of parasitism of *Antestia* nymphs by the Braconid, *Aridelus coffeae* (Brues). Malathion and methyl parathion were the chemicals most commonly used for controlling *Antestia*. A two-phase method of *Antestia* control was devised for African areas and small plantations. Trees are sprayed with 0.006% pyrethrins and their stumps are dusted with 5% DDT. The spray gives a high initial knockdown and the dust ensures that those bugs which recover from their initial paralysis are killed when attempting to climb back on the tree.

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* 6 dau chung = 1 acre

ø HK $1 = 1s.3d.

Tip Borer, *Eucosma nereidopa* Meyer: Spraying shade tree trunks with 2% DDT caused large reductions in the moth population. It is not yet clear whether this spray, complemented with cultural measures, will give sufficient control or whether there will have to be other sprays.

White Borer, *Anthores leuconotus* Pasc: It was reported from Tanganyika that the dieldrin treatment against white borer is effective for more than two years if correctly applied. The third phase of the spray campaign planned for April, 1959, was accordingly cancelled.

Yellow Headed Borer, *Dirphya nigricornis:* There was a severe, but, fortunately, fairly localized, outbreak in the Thika District. Several new observations on the life history of this pest were made. Dieldrin 0.2% in kerosene injected into the tunnels proved a useful substitute for the fumigant EDCT and was widely used as a control measure.

INVESTIGATIONS AT COAST PROVINCE *(Mr. Wheatley)*

Cotton Pests: In an assessment at Msabaha crop, value was increased by Sh. 173 per acre (75%) by controlling all insect pests by regular spraying from flowering to first picking. Counts made throughout the season revealed that the main pest losses this year resulted from *Heliothis* bollworm attack, although spiny bollworm was also prevalent. Pink bollworm populations remained low, reflecting the efficiency of the closed season in the Malindi area. Stainers occurred particularly early this season, but then virtually disappeared until late in the season by which time much of the early planted cotton was past the susceptible stage.

In a comparison of DDT/WC1 with 3:10:0 (3% gamma BHC/10% DDT) cotton dust no significant yield or quality difference showed up. Neither dust gave satisfactory red spider control. Seventy-two pounds of 3:10:1 dust per acre in six applications at seven-day intervals gave higher yields and better quality than 48 in four applications at ten-day intervals, and the economic return on the dust was higher, but not significantly so.

In a dusting trial carried out on eight peasant small-holdings, 72 lb. of 3:10:0 dust in six-weekly applications gave higher yields on every small.holding but one, but in many cases the outlay on dust was not fully recouped. This was not unexpected for late season rain not only interfered with dusting, but also led to a late season crop which largely compensated for earlier pest losses.

Maize Stem Borer *(Chilo zonellus):* In a trial at Galole on maize three full-cover sprays of DDT emulsion at 10-day intervals, commencing 11 days after germination gave better control than three sprays at 14-day intervals or two sprays only at 10 to 14-day intervals.

Mango Pests: Trunk banding with dieldrin proved ineffective in controlling ants attending coccids of mango, the principal ant species involved being the tree nesting *Oecophylla longinoda.* A spraying trial was laid down in conjunction with the pathological section to elucidate the importance of pests and diseases to mango crop. Results are not yet available.

Coconut-Coreid Bug: Bioassay work with *Pseudotheraptus* has been completed and a paper is being written. A small machine specifically designed for hand-spraying coconuts has been developed in co-operation with Long Ashton Research Station, Bristol. A large-scale spraying trial with 24 of these machines involving 2,224 coconut palms has been undertaken using one pint of 0.25% dieldrin wettable powder suspension per palm. Full results of this trial are not yet available.

INVESTIGATIONS AT RIFT VALLEY *(Messrs. Bullock & Bond)*

Barley Fly: In a seed dressing trial comparing a persistent formulation of gamma BHC, dieldrin, heptachlor, "Rogor", "Sevin" and thiometon, only dieldrin and heptachlor gave good control. In further trials, dieldrin at a rate of 5 oz a.i. per 100 lb seed gave slightly better control than aldrin (4.8 oz a.i.), but this difference was not as well defined as in 1958. Dieldrin seed dressings at rates of 2 oz, 3.5 oz and 5 oz a.i. per 100 lb seed were tested in two experiments, and 3.5 oz was found to be as good as 5 oz. Work is continuing on this aspect and it is probable that the recommended dose of 5 oz a.i. can be reduced in the near future.

Post-emergent sprays applied eight days after planting were tested in two experiments, the compounds tested being dieldrin (two rates), heptachlor (two rates), DDT, chlordane, "chlorthion", "Ekatin", "Guthion", "Metasystox" and "Rogor". In no case did these sprays affect the infestation of barley fly, as no attack occurred until three to four weeks after planting. It is evident that this cannot be regarded as a practical control measure, since it is impossible for a farmer to time the application.

The effect of a treatment on barley fly infestations on adjacent plots was tested by surrounding plots of untreated seed with (i) dieldrin-dressed seed, (ii) dieldrin-sprayed plants, (iii) untreated plants. Although the border plantings showed the expected differences (the dieldrin spray having had some effect in this case), the untreated centres were heavily and equally infested.

Tests on the effect of plant density showed that the percentage attack may tend to increase slightly with an increase of plant density, but that for practical purposes *percentage* attack may be regarded as density-independent in the early stages of growth.

Pyrethrum Thrips: Chemical methods have continued to give satisfactory control. DDT at a rate of 15 to 16 fl. oz per acre as a medium-volume spray with two applications has continued to give satisfactory results, although the likelihood of infestations of the acarine *Tetranychus ludeni* is materially increased. The use of metasystox at a rate of 5 fl. oz has been found to be successful against both thrips and mites and in some cases one spray of metasystox has successfully controlled thrips. The single spray is not yet recommended since it has not been tested under all conditions. Of other insecticides tested, parathion at a rate of 12.8 oz a.i. per acre gave very good results, but is not recommended because of toxicity hazards. "Rogor" at a rate of 4 oz a.i. was variable in action, whilst chlordane, "Chlorthion", "Dipterex", gamma BHC, "Guthion", "Phosphamidon" and pyrethrum were less satisfactory.

Methods of applying insecticides have been examined, both by using fluorescent tracers and by thrips counts. The best penetration and cover was obtained with a manual knapsack sprayer, whilst on large acreages a normal medium-volume boom sprayer was satisfactory.

Army Worm - Use of Land-Rover Exhaust Sprayer: Trials with the Land-Rover exhaust sprayer developed by Locust Control suggest that this ultra-low-volume sprayer may be used in the control of army-worm on rough grazing. Six trials were conducted of which three were successful (a 78-80% reduction being obtained), two were successful but were affected by other factors, pupation and polyhedroses respectively, and one was unsuccessful due to lack of wind and too heavy a grass cover, which diluted the spray. Although further research is necessary, the present indications are that this method will be of great value in protecting sufficient grazing for maintenance of ranch and semi-ranch beef stock and for dairy herds.

INVESTIGATIONS AT NYANZA PROVINCE *(Mr. Davidson)*

Army Worm *(Laphygma exempta):* A severe outbreak of army worm occurred throughout the Province in late February and early March causing damage to young maize, sugar cane and grazing. Minor second attacks occurred in two areas in early April. Effective control was obtained by spraying 1 lb DDT per acre in European areas and dusting with 5% DDT in African areas.

Cotton Pests: A period of drought from mid-May to late July, most intense in the lake shore areas, caused a severe set-back to early planted cotton, and a general reduction in pest populations. In spite of this, results from experiments in April-planted peasant plots in South Nyanza showed that 3% gamma BHC, 10% DDT dust at 80 and 60 lb/acre (in five applications at ten-day intervals) gave yields of 1,341 lb/acre (20% stained) and 1,198 lb/acre (20% stained) respectively while untreated controls gave 1,026 lb/acre (33% stained) Increases were economic in seven out of ten plots for each treatment. In experiments on peasant plots in Elgon Nyanza, sprays of 4 lb DDT/acre (in four applications of eight gallons at ten-day intervals) gave good control of mirids and spiny bollworm *(Earias spp.)*, with corresponding increases in green boll production, but yield figures are not available.

In a field experiment at Kibos, standard cotton dust (3% gamma BHC, 10% DDT), was found to be superior to endrin/malathion/DDT formulations both in kills of stainers *(Dysdercus spp.)* and in initial yields of seed cotton, although later pickings tended to equalize the effects.

A trial at Busia of two rates of application of DDT (four applications of 1 lb/acre at ten-day intervals and six applications of ½ lb at seven-day intervals) and two protection periods (mid-July to mid-August, early August to early September) on April-planted cotton gave slightly higher yields for the second application rate, and significantly higher yields for the later spray period, which corresponded to peaks in the populations of mirids and spiny bollworm.

Biological Control

See PANS 1960 *6* (4), 410.

STORED PRODUCTS TEAM *(Messrs. Kockum, Graham and Ashman)*

The use of a toxic fumigant, aluminium phosphide, was demonstrated and this may prove of great value to the wheat industry as small consignments infested with *Calandra oryzae* weevils can be dealt with under simple conditions. Storage of cereals on farms in the Coast Province has been investigated and it has been found that BHC is ineffective in preventing insect infestation when used at the legally permitted rates. Malathion on the other hand, shows promise when admixed with grain, but not as a general surface spray in stores. Reinfestation by *Tribolium castaneum* and *Ephestia cautella* continues to take place in spite of the use of dusts and wettable powders of malathion applied to the outside of grain stocks. The admixture of malathion which has proved successful was at a rate of eight parts per million, i.e, that recommended by the Colonial Code of Practice.

A stack dusted with 1% lindane in diatomite at a rate of 2 oz per bag was badly damaged after five months as was an untreated control stack. The recommendation for dusting layers of maize has therefore been withdrawn.

A large 13-month crib experiment was completed. It was found that coumarone resin added to lindane in kerosene was not superior to lindane alone when sprayed on the hessian outer wall lining.

Temperature studies have been made of the interior of large experimental stacks, and have proved a valuable tool in assessing the degree of infestation.

(Department of Agriculture Annual Report 1959. Vol. 2)

MALTA

Public Health Measures.

Insect Control: The most prevalent insect pests are house-flies and cockroaches which disappear or hibernate during winter and resuscitate again throughout the rest of the year, late spring and early autumn being the high seasons for flies. During the last few years a steady decrease in the fly population has been noted in towns and many villages and the decline was much more in evidence during the year under review.

Control of flies is by spraying or dusting with 5-10% DDT. In some instances, 'Gammexane' in liquid or powder form, was used as a larvicide on refuse dumps and manure heaps and the results were satisfactory. Arrangements are in hand to provide and install in places most frequented by flies, portable frames mounted with twine soaked in dieldrin and the good results obtained in other countries, through this simple device, are anticipated.

Cockroaches were normally controlled by the application of DDT in liquid or powder form to their usual haunts and runs; on few occasions insecticidal lacquers were employed and the lasting residual properties of these preparations proved very efficacious. However, their use on a large scale was economically prohibitive.

The few complaints of bed-bugs infestations made to the Department, came from communal institutions and were dealt with by the application of a residual deposit of DDT produced by a powerful "rotary blower". Dusty and dirty floors of unoccupied rooms were sometimes found infested with fleas. A spray with Cresol Saponatus, followed by washing and cleaning the floors, was always found to be practical and safe measure for the extermination of fleas. In the treatment of infested cloths and bedding, insecticidal powders were applied.

Complaints about domestic mosquitoes ((*Culex*) were few and the usual control measures were adopted. These involved the detection and removal of undisturbed waters, where eggs were laid and larvae developed, and an attack on adult mosquitoes with a liquid formulation of DDT. When removal of the stagnant water was not feasible a film of kerosene, or other light oil, dispersed on the surface of the water, was the alternative method which invariably produced a complete larval control.

Houses where cases of Kala-Azar had occurred and their surroundings, were always treated with DDT as a precautionary measure against *Phlebotomus*, the insect vector of the disease.

Rodent Control: Good results are reported with warfarin. This is a slow acting poison which when ingested regularly in small doses over a period of days causes haemorrhage in rats and mice. Because it is slow acting it develops no bait shyness, and as no warning is given in taste, the rat continues to feed unsuspectingly until death ensues. The various poisons used in the preparation of baits (quantities in ounces) were as follows:

Warfarin	4343½	Red Squill Powder	71½
Zinc phosphide	1935¾	Arsenic	1

One hundred rats of the *Rattus norvegicus* species were caught during the year by different types of traps from buildings and sewers. Sixty-five of the rats caught were submitted to the Bacteriological Laboratory for flea index examination.

The incidence of Murine typhus cases showed an increase over that of the preceding year. Immediate and special attention was given to the premises and their surrounding areas whenever each case occurred. As no rat-borne disease was notified, the possibility of food contamination by rats and mice had not been excluded.

(Report on the Health Conditions of the Maltese Islands and on the Work of the Medical and Health Department for the Year 1958.)

MAURITIUS

Malaria: The residual spraying unit is still in existence with Headquarters at Port Louis and Forest Side. No routine spraying has been carried out since August 1958 and when the sprayer operators are not engaged in the emergency spraying of markets, hospitals etc., they have been engaged in minor drainage work and oiling. 10,092 rooms were sprayed during the year with DDT technical in kerosene, DDT wettable powder, "Psylortox" or BHC technical. The last was mostly used for the suppression of fleas and bugs.

During 1959 a mild epidemic existed in Grand Port and in Riviere du Rempart districts and lasted throughout the year. It is suggested that there is now a semi or non immune population and unless strict surveillance is applied there could be an outbreak of epidemic especially if *A. gambiae* be the vector.

Schistosomiasis: Schistosomiasis was diagnosed in 423 cases in 1959 as against 274 cases in 1958. This increase might have been the consequence of the awakened interest in the disease caused by the survey conducted by Dr. S.G. Gaud of the World Health Organisation during May and June of 1959.

Mosquito Studies: Further work was carried out this year on the diurnal resting places of those mosquitoes which are known vectors or suspected vectors of certain diseases in Mauritius. *Culex fatigans* may be classified as more endophilic (as far as human habitations are concerned) than any of the other species. *Anopheles gambiae* has a marked preference for cowsheds while *Anopheles coustani* and *Culex tritaeniorhynchus*, though showing a strong tendency to rest under bushes (especially the common *Lantana camara)*, are, to a lesser degree, frequenters of cowsheds and stone wall crevices. *Anopheles maculipalpis* which is a comparatively rare species in Mauritius seems to rest mainly in stone wall crevices. These three species of Anophelines and *C. tritaeniorhynchus* are considered as practically non-endophilic.

The study of the host-preference of Mauritian mosquitoes was continued. *Anopheles gambiae, A. coustani* and *A. maculipalpis* are more zoophilic, feeding mostly on cattle either kept in stables or outside, than anthropophilic. *Culex fatigans* is strongly anthropophilic but feeds also to a certain extent upon poultry and other birds.

Susceptibility tests of blood-gorged adults of *Anopheles gambiae* Giles, to DDT and dieldrin, using both the standard Busvine-Nash method and the pre-impregnated paper technique as recently recommended by WHO, have again showed that this mosquito is still susceptible to both insecticides. Tests with DDT gave an average LC50 of 1.40% by the Busvine-Nash method (range 1.07 - 1.60% and 0.91% by the new pre-impregnated paper technique (range 0.85 - 1.15%). The average LC50 obtained from the dieldrin tests was 0.115% using both methods of testing (range 0.94 - 0.136%).

Fly Control Studies: Further tests were carried out this year in order to compare the residual effectiveness of DDT, diazinon and "Muscatox" against the house fly, *Musca domestica L.*, when these compounds are applied on various surfaces. The wettable powder forms of these insecticides were first suspended in water and then sprayed (using a 1-gallon polythene sprayer) so as to give required deposits on ply-wood panels either plain, whitewashed (lime), mud-cowdung plastered or plastic emulsion coated, viz:

DDT 50% at 300 & 400 mg a.i. per sq. m.
Diazinon 40% at 200 & 500 mg a.i. per sq. m.
Muscatox 30% at 300 & 3000 mg a.i.per sq. m.

House flies, 3-4 days old, were exposed for 10 minutes to the variously treated surfaces, using the Petri dish method, and then transferred for recovery to paper cups closed at the open end with mosquito netting. Food medium consisting of a cotton wool pad soaked with a 10% sugar solution was available to the test insects throughout the recovery period. Mortalities were recorded after 24 hours. Sixty flies, in 3 replicates of 20 each were used per test. Control tests for each type of surface were also carried out. The tests were carried out weekly for 12 weeks, using the same treated panels each time.

Under the conditions prevailing in Mauritius, diazinon wettable powder when applied over porous surfaces such as plain, unpainted, soft wood, whitewashed (lime) and mud-cowdung at the dosages quoted, seems to be rather quickly absorbed so as to be only partially effective against house flies for about 2 weeks. On non-porous surfaces, such as plastic emulsion coated surfaces, the residual effect of diazinon applied so as to give a deposit of 500 mg, a.i. per sq. m. lasts about 3 weeks.

Deposit of DDT wettable powder on mud-cowdung surfaces even at a rate as high as 2000 mg a.i. per sq. m. is rapidly absorbed and also probably suffers some deterioration resulting in practically no residual effect against flies. DDT wettable powder seems to be fairly effective, at 2000 mg a.i. per sq. m. for a few weeks on plain unpainted soft wood while on whitewashed surfaces its lethal effect on flies is of very short duration. On non-porous surfaces (plastic emulsion coated) its residual effect, when applied at a deposit rate of 2000 mg a.i. per sq. m. lasts about 3 weeks.

The residual effect of "Muscatox" wettable powder when applied on plain unpainted soft wood at the rates quoted is spectacular and lasts for more than 10-12 weeks. The same applied to deposits of 3000 mg a.i. per sq. m. on plastic emulsion coated surfaces On whitewashed surfaces, "Muscatox" is somewhat absorbed and its effect is thereby weekly reduced but the mortality rate of house flies (after an exposure period of 10 minutes) remains fairly constant and fluctuates around 50% from the 5th to the 12th week after it has been applied. Whitewash (lime) does not therefore seem to affect to a large extent the toxicity of "Muscatox" to house flies in Mauritius. The potency of "Muscatox" on mud-cowdung surfaces is a little short-lived though the insecticide remains effective for a little more than 3 weeks after its application.

(Medical and Health Department. Annual Report 1959.)

Agriculture

Coconut Beetles, *(Oryctes rhinocerosL):* In the island of Diego Garcia, one of the Lesser Dependencies of Mauritius, where the rhinoceros beetle is a major pest, biological and insecticidal control is being enforced. Regular shipments of the Histerid predator *Leionota quadridentata* are being sent there. Insecticidal control is carried out on young palms using BHC/fine sand mixtures in the leaf axils.

The Carabid, *Scarites madagascariensis* is also being collected in Madagascar for despatch to Diego.

Attacks of *Raoiella indica* Hirst have been especially severe on seedling and adult palms. Spraying with "Duphar" "Tedion V-18" or "Rogor 40" + chlorphenyl chlorbenzene sulphonate or "Metasystox" gives good results.

Tobacco pests: "Dimecron" (phosphamidon) has been found to give almost 100% control against the tobacco leaf miner, *Gnorimoschema operculella* Zell. and against the tobacco aphis, *Aphis gossypii* Glov. Trials with "M.C. 47" and "Orthodibrom 8" are in progress.

Against the tobacco budworm, toxaphene and "Dimecron" have both been found to give excellent control, especially the former which is also cheaper. The tenebrionid beetle *Gonocephalum simplex* F. is a major pest of growing tobacco plants in some localities.

Careful investigations of tobacco pests have led to the discovery of a new species of mite in seedbeds which causes severe stippling and stunting of young leaves. Taxonomic and biological studies are in progress.

Tea pests: Two aphids were collected on tea for the first time. These are *Toxoptera aurantii* B.d.f. and *Macrosiphum (sitobion) africana* H.R.L. and both cause severe curling of tender leaves. The two species can be controlled by "Dimecron" and "Rogor 40". Investigations are being carried out to see if these systemic insecticides do not have tainting effects. The soft brown scale, *Coccus hesperidium* L. also causes severe damage on young tea plants. On *Crotolaria* which is planted in inter-rows of tea bushes, severe attacks of the Mirid bug: *Campylomma* sp. were recorded.

Citrus pests: The use of "Dieldrex 15" on trunks has been found very effective against the black ant, *Technomyrmex detorquens* Wlk. Its application is being extended in orchards. "Dimecron" applied as sprays has been found to be an outstanding insecticide in the control of the citrus aphid, *Toxoptera citricidus* Kirk., and other scale insects parasitic on the plant as well as lepidopterous pests. On locally grown oranges and grapefruit, the mite, *Brevipalpus phoenicis* (Geijskes) is at present most troublesome. An unidentified white fly also causes severe pseudogalls on leaves.

Tomato pests: The tomato fly, *Pardalaspis cyanescens* Bezzi, which threatened tomato plantations throughout the island is now apparently under control. "Dipterex" has been found to reduce heavy infestations to negligible proportions. "Dipterex" has the added advantage of controlling *Heliothis armigera* Hb., the tomato fruitworm. The Muscid fly, *Atherigona excisa* Thorns, also causes damage on fruits and is controlled successfully by "Dipterex".

Identifications have shown that a new acarine pest on tomatoes, *Vasates lycopersicae* (Massee) exists in the island. "Tedion V-18" is now being used regularly for control. "Rogor 40" + p-chlorophenyl p-chlorobenzene sulphonate, "Phenkaptone" and "Chorthion" can check the pest. "Metasystox" is effective, but owing to its accumulation in tomato fruits, is not recommended. *Tetranychus marianae* McG, a serious mite pest can be controlled with the previously mentioned acaricides and "Kelthane".

Cajan pests: The imported parasites of cajan pests: *Bracon cajani* Mues. and *Eiphosoma annulatum* Cress seem to thrive in Mauritius. This year a record crop was obtained. In some localities 90-95% of the pods were free from pests and in the areas where attack was most severe, only 15% of the pods were affected.

A new parasite, *Hetorospilus etiellae*, is now being introduced from Puerto Rico through the Commonwealth Institute of Biological Control.

Miscellaneous: The banana weevil, *Cosmopolites sordidus* Germ., has been found to be ubiquitous in the island. In an attempt to control it two Histerid parasites, *Leinota quadridentata* and *Plaesius javanus* Erichson, were introduced. Further investigations are in progress.

Reports of severe attacks on breadfruit and mango trees by *Batocera rufomaculata* Degeer have occurred in many areas and the introduction of two hymenopterous egg parasites: *Louricia oviora* Ferriere and *Ooencyrtus batocerae* Ferriere is under study. Sporadic damage to *Albizzia procera* (Bois Noir Blanc) by *Xystrocera globosa* Olivier was also noticed. The introduction of the hymenopterous parasite: *Sclerodermus immigrans* Bridw. is being considered.

Nacoleia praeteritalis Wlk., the leguminous leaf tier and *Lecithocera effera*, Meyr, caused severe damage on bean at Richelieu.

Utetheisa cruentata Butl. which was a serious pest of *Tournefortia argentea* L. in past years can now be successfully controlled by toxaphene and "Dimecron".

Stomoxys Research: The two common species of stable flies in the island are *Stomoxys nigra* Macq. and *S. calcitrans L.* Insecticidal routine residual sprayings on walls with malathion, diazinon, "Baytex", "Dipterex", "Trolene" and DDT, together with malathion and diazinon in baits, brought marked reduction in fly populations. Fogging with pyrethrins and synergists (using swingfog machine or microsol apparatus) is also necessary, especially in wet localities. "Baytex" is a most promising insecticide, for it has a very long residual effect. Diazinon is better than DDT in some localities.

The use of dimethyl phthalate as a repellent is being investigated.

Associated with stable flies is *Musca domestica vicina* L. This fly breeds in farmyards manure. Insecticide control of the larvae with diazinon malathion and "Agrocide" 25% w.p. is being carried out.

Giant Snail: A search for *Lamprophorus tenebrosus* Walker, the recently introduced predator of the Giant Snail, again gave negative results. The predatory snail: *Euglandina rosea* imported from Hawaii is now being bred in the laboratory. At present the only other practical methods of control are baiting with meta snail pellets or with "Slugit" liquid and meta bran baits. *Helix aspersa* Muller is also a serious problem in some localities.

(Annual Report of the Department of Agriculture for the year 1959).

Sugar cane

Stalk Borer: *Proceras sacchariphagus Boj:* This pest contributed substantially to the loss caused by the intense cyclones of 1960 owing to breakage of canes at weak points where borer galleries occurred. The insect is, however, responsible for considerable annual losses irrespective of cyclonic winds, which serve to emphasize its presence, and in the last ten years or so it has gained importance in the higher altitudes, probably due to the change in the varietal composition of the crop in these regions. The borer is undoubtedly the most important, as well as the most conspicuous, pest of cane in the island and research upon the various aspects of its biology and upon control methods is being intensified.

Introduction of foreign parasites for trial, chiefly against the stalk borer, was continued. A total of 122 consignments of parasite insects were received by air from India through the cooperation of the Commonwealth Institute of Biological Control and, although many of them were failures because of mortality in transit, the following species were released: *Goniosus sp.*, *Melcha ornatipennis* Cam , *Stenobracon deesae* Cam., *Stenobracon nicevillei* Bingh., *Iphiaulax sp.*, *Sturmiopsis inferens* Tns., and *Apanteles sp.*

White Grub, *Clemora smithi:* No further data could be obtained during the year from field trials owing to the destructive effect of the cyclones. It has, however, been decided not to pursue this work further in view of the disappointing results obtained. When this project was initiated, the use of aldrin or chlordane at planting appeared to offer a simple and cheap method of preventing white grub infestation for a prolonged period while reports indicated also that growth improvements might result from suppression of other soil arthropods. Sufficient is known to conclude that, at least under local conditions and with the varieties grown, insecticidal doses cannot be safely applied to the soil and further work along these lines is not at present desirable.

Army Worm, *Leucania loreyi:* Several outbreaks were again reported during the year, always on young ratoon shoots in fields which 20-30 days previously had been burnt before cropping. The outbreaks are believed to result from a migration of moths into burnt fields to feed upon the juices forced out of the cane stalks by the heat. The eggs deposited by the moths give rise to larvae which defoliate the young shoots which subsequently emerge.

Pink Borer, *(Sesamia calamistis)* lives primarily in wild grasses and a start was made at the end of the year to search for and identify its various host-plants as a preliminary to a more exhaustive study of the pest.

(Mauritius Sugar Industry Research Institute, Annual Report 1960).

NORTHERN RHODESIA

Tsetse Control

General: The Tsetse Control division of the Department had a busy year, throughout the Territory. Among the possible control measures, increased emphasis began to be placed on the use of insecticides, but it must be stressed that nature's abhorrence of a vacuum applies particularly to tsetse control problems, irrespective of the methods employed. Only if reclamation is backed up by settlement and proper land use can any eradicative measures be permanent and fully economic. Without these, every anti-tsetse operation once started must be carried on indefinitely, and no treasury can view with equanimity a steadily increasing bill for this purpose. There is no prospect, with present knowledge, of eradicating the enormous tsetse fly belts of Northern Rhodesia; eradication is only economically feasible in small discrete patches of infestation. To achieve a great reduction in fly density is comparatively easy, but the residual light infestation is an elusive and resilient opponent on which to land a knock-out punch. Marked improvement in the position was achieved in Kalomo and east of Lusaka, but in Fort Jameson the position was static, and in Barotseland and Mwinilunga large extensions of fly belts were observed. Operations are costly, and it is always necessary to weigh the costs against the economic advantages to be gained.

Insecticides - Southern Province: In the Gwembe Valley, where there are three tsetse control stations, selective clearing of riverine vegetation and residual insecticides have given good results, and several pickets have been closed as redundant. In the Chirundu sector, 120 square miles north of the Lushitu River have been freed of fly, and operations are now being planned in a block of 150 square miles south of the river. Much use has been made in the valley of 2% dieldrin emulsion applied by spray pump to the vegetation. Numerous surveys were carried out in the Chaanga sector, and 52 fly rounds were laid out.

Insecticides - Central Province: In the area east of Lusaka and Chisamba there are three stations, at Chisamba, Chongwe and Chinyunyu. Operations were aimed at clearing the light density of fly remaining on the plateau and preventing re-infestation from the Luano Valley. On the plateau, thermal aerosols of 1% gamma BHC were combined with escarpment edge spraying, using 5% DDT. On all fly rounds on the plateau, only 88 flies were caught over the year, as compared with 762 in 1959. Picket catches were also sharply reduced, and most flies are now caught at the picket covering the main path from the Luano Valley.

(Ministry of Land and Natural Resources. Annual Report of the Department of Veterinary and Tsetse Control Services for the Year 1960).

TANGANYIKA

Coffee Pest Control: Experimental evidence presented by Mr. R.G. Tapley has shown, in the author's words , "that the use of DDT and dieldrin insecticides can by reducing parasite populations generally, intensify an outbreak and prolong an epidemic. These insecticides also appear to affect the populations of each species of parasite in different ways. DDT, for example, tends to favour the survival of *A. ritchiei* and the dieldrin treatment favours *Ageniaspis* sp. Both of these species were considered to be unimportant two decades ago, are now the dominant species. The status of *P. coffeicola* which alone of the once important species remains more or less unchanged, was also unaffected by DDT and certainly not entirely suppressed by dieldrin. From this it can reasonably be concluded that the change of status of most of the parasites may well be attributed to the use of DDT, which was widely used up to 1958, and dieldrin, which has been used more extensively since that time as coffee sprays for insect control.

It would be interesting to see if the leaf-miner parasite complex as described by Notley still existed in coffee which had remained unsprayed with the newer, persistent insecticides and only treated with those older insecticides as used two decades ago. Unfortunately, no such coffee is known to exist on Kilimanjaro, and the best that can be done is to set aside an area of coffee, leave it unsprayed for several years and see if the old complex is restored. If this is the case, and if the new complex remains the same in sprayed plots, then the case against the use of DDT and dieldrin in coffee would be very convincing.

The chain of events which eventually leads to an epidemic appearing is not understood, but it may well be associated with the annual oscillation of the degree of parasitism from almost 0 to 100%." It is further suggested that an epidemic is linked in some way with climate.

(Research Report 1960, Coffee Research Station, Lyamungu, Tanganyika.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

CONGO

Malaria and Bilharziasis control in the Belgian Congo

Malaria

Ruzizi Plain: 66,380 inhabitants were protected by spraying annually, the interior walls of all dwellings and outhouses. The insecticide programme was supplemented by a weekly dose of pyrimethamine per person for 10 weeks. The insecticide, 90 g DDT at 75% per litre, was applied with an "X Perth Hudson" compression sprayer.

Rutshuru Plain: 36,517 inhabitants protected as described above. The drug was replaced by chloroquine.

Walungu Plain: 2,986 inhabitants protected as above.

Lower Congo: In this region, 300,000 persons were protected by a twice yearly house spray during which all interior walls of all dwellings and outhouses were treated. The area of the region is about 17,000 km^2 and the work was carried out by a firm specialised in DDT spraying, under the supervision of the Provincial Public Health Service of Leopoldville. 14,513,669 m^2 of normal surface were sprayed, using (1) 62,320 kg of DDT 75%, or 46,740 kg of full-strength DDT powder, and (2) 3,620 litres of full-strength DDT. The quantity of full-strength DDT per m^2 was 2.7 g.

Insecticide spraying was carried out by 3 teams of 8 men each with its leader, together with two mechanics for maintenance and repair of equipment and two clerks. Birchmeyer-Senior sprays were used. The total cost of the spraying came to about 5,400,000 fr, which amounted to about 9 fr per inhabitant protected. This does not include the cost of essential technical research and subsequent checking.

Ruanda-Urundi: In Ruanda-Urundi 4,033,635 persons living in rural areas were protected by house spraying during which all interior walls of all dwellings and outhouses were treated. The area of the protected territory is 40,000 km^2. Roofs of the dwellings were not treated because they are continually covered with soot from open fires inside the cabins.

The three types of huts found in rural areas are as follows:

(1)	round huts shaped like beehives	22%
(2)	round cylindrical huts	38%
(3)	rectangular huts	40%

The average wall area of houses treated was 35 m^2, including the partition but excluding the roof.

The work was carried out under contract by a commercial firm, under the technical supervision of the Provincial Health Service of Ruanda-Urundi.

A total of 1,680,727 houses in rural areas were sprayed with 75% DDT at 5% strength, at the rate of 2 gr of full strength DDT per m^2; the total surface sprayed was 37,825,385 m^2.

The entire cost of spraying operations was 9,400,000 fr for 4,033,635 inhabitants in rural areas, or 2.3 fr per campaign per person protected.

Bilharziasis

Ruzizi: The activity of the Ruzizi Medical Mission has been reviewed over the period mid 1956 to 1959. The threat of infection which increased with the development of irrigation, rice plantations and fish ponds has been partially offset by health education and the application of copper sulphate and sodium pentachlorphenate. These compounds failed however to reduce the incidence of *S. mansoni* beyond a certain threshold figure. In the years 1956 to 59 inclusive the percentage of population infected was 10.1, 4.8, 4.1 and 5.4 respectively. Furthermore, the usefulness of those compounds was limited by the need for thorough stream clearance beforehand. Recently "Bayer 73" has given promising results against molluscs, eggs and cercariae, and it is expected that substantial progress will be made with this compound.

Katanga:

The Authors Report: In two brooks near Jadotville (Katanga, Belgian Congo) eradication of the snails has been attempted with a 5 ppm concentration of Na PCP for a period of 72 hours. Before the application of the molluscicide physico-chemical and biological conditions had been investigated on different points of the brooks.

The Na PCP concentrations had been tested downstream and the dispersal characteristics of the product are criticized. It has been observed that the dosage level is rising everywhere in the flow when the exposure time exceeds 24 hours.

The two treatments gave a very good result. In the Kapumpibrook, which has a good running flow, no *B. pfeifferi* were found for a period of 4 months over a distance of 5.200 m. below the point of application. In the Kapononabrook, with a very slow flow, the surviving vector snails *B. pfeifferi* and *B. africanus* were extremely rare for a period of 6 months over a distance of 2.200 m ; yet at 3.400 m. there was no effect on the snail population. Nowhere on the treated distances did this species disappear for longer than 2 months and repopulation is quick and abundant.

A particular exploration of the brooks is necessary for a successful molluscicidal treatment; it has been observed that the treatment will be completely inefficient when the little channels, backwaters, et., just next the rivers, are not treated at the same time.

The most important chemical reactions observed in the brookwaters during and after the treatment are; increase of the organic matter, sulphuric hydrogen and chlorides. These reactions are inverted as soon as the molluscicidal application finishes.

Calcium and magnesium varied confusedly. Sulphates decreased or disappeared during the treatment. Dissolved oxygen, pH, carbonates and bicarbonates, alkalinity, free carbonic acid, kalium, natrium and phosphates dis not change very much.

Among the biological reactions of the climax the heavy destruction of the green algae will be noted; but they reappear immediately. The activity of Na PCP did not change the composition of the zoophytical associations, and the emerged aquatic plants suffered no damage.

(3rd Inter, African Conference on Medical co-operation Luanda, Angola, 15-23 September 1961).

ISRAEL

Grapefruit Pest Control: Experiments were conducted in 1957, on control of the citrus mealybug *(Pseudococcus citri* Risso), in 5 grapefruit orchards, by means of organophosphate insecticides. From June until picking time, all dropped fruits were collected and examined for mealybug infestation. Mortality determinations were made from fruit picked several weeks after spraying. During the same year, although all orchards were in the same region, noticeable differences were found in percent fruit drop, degree of infestation, and time of first appearance in the orchard.

Parathion alone, or in combination with malathion, gave instant high kill of mealybugs; next in order was diazinon. Malathion or 'Tetram' alone gave unsatisfactory results - sometimes being identical with those on untreated trees. The best control on infested dropped fruit was obtained with one of the parathion formulations, or a mixture of parathion and malathion. Malathion alone, or diazinon, gave less satisfactory results, and the number of infested fruits in plots sprayed with 'Tetram' exceeded that of the control. In the case of heavy or medium infestation, 20-50 less fruit dropped per tree after spraying, whereas in mildly infested orchards, only 7-15 fewer fruits dropped per tree.

(Z. Avidov, S. Erlich and S. Gothielf. Studies on Citrus Scale Insects in Israel. The National and University Institute of Agriculture. Bull. No. 65, Oct. 1960.)

PHILIPPINES

Locust Control: Airplane spraying with four P.A.F. planes, one B.P.I. plane and one hired commercial plane for the control of locust flyers, and ground spraying of 'Folidol M-50' and lindane and application of poison baits were being done particularly in accessible areas. Task force units equipped with transportation facilities, power spray pumps, and insecticides worked day and night to destroy more flyers in their roosting places. The Bureau personnel and the planes spraying insecticides were doing well in the extermination drive. Municipal officials, teachers, and pupils were also employed in combating the locust infestation.

During the fiscal year, infestation of locusts in the above-mentioned provinces covered an area of 43,724 hectares. With the assiduous campaign affected, the tremendous number of 353,317 cavans of hoppers and flyers was killed. A total of 150 Martinez birds was shipped to Davao Experiment Station to help in the control of locusts.

Rodent Control: Infestation covered an aggregate area of 599,378 hectares, 272,789 hectares of which were successfully treated during the fiscal year. The most popular control measures employed were dispersion of corn grains impregnated with "1080", warfarin, white arsenic poisoned baits and cyanogas. Damage to crops ranged from 1.04% to 3.44% during the fiscal year.

(Annual Report of the Secretary of Agriculture and Natural Resources for the Fiscal Year ending June 30, 1959.)

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TROPICAL PESTICIDES RESEARCH UNIT, PORTON

ANNUAL REPORT, 31ST MARCH, 1961. CPRU/Porton/Report No. 185.

Insecticide Screening Tests

General Progress: The Unit is now concerned with Stage II testing in the Programme of Research on the Evaluation and Testing of insecticides organized by the World Health Organization. This involves the determination of the residual properties of new compounds which seem sufficiently toxic as larvicides and adulticides in preliminary screening to be considered as possible new insecticides for control of anopheline mosquitoes. The compounds are formulated, sprayed onto a series of representative building materials and their contact toxicities measured at intervals by exposure of mosquitoes.

Large supplies of dried soils showing a range of effectiveness in sorbing and decomposing insecticides have been sent from Arusha and are being used to form standard porous test surfaces.

"Baytex" and malathion remain the most promising of the organo-phosphorus compounds tested but are still relatively ineffective on porous surfaces.

Problems in Formulation: Many of the candidate compounds in the Testing Programme are, and will be, either technical or pure substances and difficulties have arisen in using them in standard formulations. They should obviously be used as wettable powders if they are to be employed effectively on porous surfaces. As the wettable powder needs to accommodate substances of varying physical properties it was decided to restrict the concentration of active ingredient to 25%. At this level, liquid insecticides and highly potent solid insecticides are effective as residues but the less potent solids, such as DDT, are not. This lack of activity is probably a result of high ratio of filler to insecticide, the decrease in availability being accentuated by the rather critical pick-up conditions which occur with an anopheline mosquito in our test method. These difficulties have necessitated further work on the relationship between formulation, surface and availability, and this is still proceeding.

Studies of Residues: Chemical determination of the behaviour of insecticide residues has continued. In general, rates of evaporation from relatively non-porous surfaces as filter paper depend upon dosage so that plots of logarithm of amount remaining versus time are straight lines. However some materials such as "Baytex" and malathion show marked change of slope as time goes on, and this may have been due to formation of derivatives with lower vapour pressures. This chemical change would not be detected by the method of analysis used and experiments with these compounds are being repeated with more specific methods.

It has been confirmed that the decomposition of "Resitox" in dried soils follows a course similar to that induced by acid-catalysed hydrolysis. This mode of decomposition seems to be general for those insecticides whose products have been identified and where a distinction is possible between acid and base-catalysed hydrolysis.

Determination of Phenols: The colorimetric procedure using 4 amino-antipyrine has been suitably modified for the determination of "Sevin", "Trolene", "Dow-ET-15" and a range of phosphoroamidate esters of various phenols.

Mosquito Esterase Studies:

Measurement of Inhibitory Effects: Quantitative measurements of acetyl cholinesterase activity have now been made with homogenates and the enzyme inhibition correlated with dose of insecticide and symptoms of poisoning.

Inhibition increased with dose but knock-down and deaths did not occur until it reached approximately 20 to 30%. Thereafter the physiological response increased until inhibition had reached about 70 to 80%, when a complete kill was obtained. These critical levels of total acetyl cholinesterase were common to both *A. aegypti* and *A. stephensi* and several insecticides.

Doses to give the lower critical level were also given to mosquitoes which were then kept for up to 3 days. Esterase determinations on samples showed that this inhibition was rapidly attained and afterwards remained constant. There is therefore no spontaneous reactivation or appreciable syntheses of new enzyme in mosquitoes. This was so even during a feeding cycle. A consequence is that small, sub-lethal, doses should be cumulative and this has indeed been found. Cumulative action also occur between different compounds having a similar mode of action and the effect of mixtures on enzyme inhibition is now being studied.

Synergism: Synergistic action between organo phosphorus compounds and between them and chlorinated hydrocarbon insecticides has been frequently claimed. It would be useful to know how this synergism comes about and to separate physical, chemical and biological effects. In addition, the practical aim of this work on esterases is to improve the efficiency of organo-phosphorus insecticides by using them in formulations which facilitate their performance by improving persistence, pick-up or action in the insects themselves.

Experiments with Granules.

Attapulgite granules are obtainable in two forms with different rates of disintegration, namely the quick breaking "AA" RVM (regular volatile material), and the slow breaking "A" LVM (low volatile material). The rate of break-up in water has been examined by shaking between filter papers to simulate the conditions within the whorl of a maize plant.

The exact relationship between the conditions of the experiment and the conditions within the whorl of a maize plant is problematical. However the experiment provides a controlled environment in which it can be shown that both materials reach a constant level of break-up after three hours shaking. When this point is reached, the proportion by weight of the fraction that passes B.S.S. size 85 (178 u), for the RVM material is 3.25 times the amount of the same size-fraction for the LVM material. The amount of the fraction greater than 30 B.S.S. (500 u) for the RVM is 1.36 times the amount for the LVM.

There is reason to believe that the rates of break-up are different when endrin is absorbed at a strength of 1%. This is being investigated. Other results have already been reported in PANS 1961, 7 (1), 101.

Maize Stalk Borer

Breeding and Life History: The distribution range of *Busseola fusca* in East Africa is determined by temperature, and the effect of this factor on the duration and completion of the life cycle is being studied. At a constant temperature of 30°C, the maximum weight before pupation is reached at about 28 days instead of about 43 days at 21°C. Adults are able to emerge at 30°.

Records of the increase in weight of larvae feeding on different parts of the maize plant at 21°C suggest that greater initial growth of 1st instar larvae occurs on young maize leaf tissues than on cob (seeds) and stem (pith), but that later growth is greatest on cob tissues, and less on leaves and stem. This is in agreement with the nutritional value of these tissues and can also be related to the type of tissue available to the different stages of the insect.

In breeding *Busseola fusca* it has been found possibke to use a spiral of polythene sheet or waxed paper as an artificial oviposition site. Eggs are laid normally under the overlap instead of under the leaf sheaths of maize plants. Hatching occurs satisfactorily.

Pick-up of Insecticides: Work has been continued on the pick-up of particulate deposits. Following the investigations by Johnstone and Berry with fluorescent tracers (Report No. 184), the suitability of primulin as a laboratory tracer for insects has been confirmed. It is easily obtainable, highly water soluble and detectable at a dilution of 10 µg./litre with a coefficient of variation of 10%. The coarse material is filtered, and calibrated as a solution in 80% ethyl alcohol in distilled water by means of a fluorimeter. The primulin on insects is washed off with water and the solution made up to 80% alcohol for estimation. Solid primulin is affected by light, however, and the solution is not stable.

Results with this material show a rate of pick-up by *Busseola fusca* larvae similar to that of croceine scarlet, reaching a maximum for a 150 mg caterpillar of 40-50/ug, after walking 100 cm. on Whatman No. 1 filter paper. The amount of pick-up from different surfaces has been compared by estimating the amounts picked up after 1, 3, and 9 cm. walking on a deposit, giving three points on the straight part of the regression line of log pick-up on log distance. It has been found that the amount picked up and the rate of pick-up are greatest from glass, less from Whatman No. 1 filter paper and least from a rough textured flock paper. This work is continuing.

Application of Pesticides from Aircraft.

Dragonfly Helicopter: A continuation trials programme to obtain quantative information on cover by measuring deposition on opposing faces of both horizontal and vertical, rigid and flexible sampling targets, mounted in positions 6" and 36" above ground level has been completed. With the droplet spectra investigated, (180 - 350 u v.m.d.), deposition on the underside of the horizontal targets, both flexible and rigid, only reached a significant level at the lowest combinations of height and speed. This deposition was most marked when the v.m.d. of the spray was least (180 u). For this drop spectrum with the aircraft flown at 10 feet and 10 m.p.h. deposition on the underside of the flexible horizontal targets approached that on the upper side, while the overall deposition on the flexible horizontal targets exceeded that on the rigid targets. In this trial the deposit on the vertical targets exceeded that on the horizontal, indicating that the droplets were being carried laterally at high speed and it appeared that due to their own fluttering the flexible horizontal cards exposed a greater area of both faces normal to the moving droplet stream than their rigid neighbours and so received a greater deposit. Another interesting feature of this particular trial was the high deposit measured on the leeward faces of both flexible and rigid vertical targets under the port side of the aircraft, while to the starboard side the windward face of the targets received practically the entire deposition. With the main rotor rotating anti-clockwise this appeared to indicate an anomalous air circulation, unless the airflow through the tail rotor was sufficiently powerful to reverse the flow.

Full details of these trials are recorded in Report No. 183.

It is proposed that investigations of the performance of the modified S.A.6 installation should be concluded by assessing the nature of spray deposition on a suitable growing crop under those conditions which the present experimental work has shown to be particularly relevant.

Cessna 182 Aircraft: A Cessna Type 182 aircraft, complete with a Sorensen boom and nozzle installation, was purchased to replace the Auster J.5G aircraft VR-TBR at Arusha. A set of four Britten-Norman Micronair rotary atomisers was also obtained and the aircraft was modified to enable them to be fitted as an alternative device to the boom and nozzle equipment.

Dyed water was sprayed from the Britten-Norman installation. At 8 g.p.m. with a windmill blade setting of 27½°, and flying at 95 m.p.h., the v.m.d. of the spray deposit produced was 93 µ. Spray cut-off cleanly, and no aircraft contamination was observed. Further details of this work are contained in Report No. 182.

Wind Tunnel Studies: The sampling efficiency of a coarse aerosol by plane square obstacles of side-length 0.5 - 3", set normally to the airstream has also been measured, and was found to be greater than that for the corresponding section of a cylinder of identical projected cross-section. This was attributed to the more rapid parting of the flow streamlines required on approaching the plane obstacle, with a probable earlier breakdown in laminar flow giving a resultant increase in inertial deposition.

Quantitative measurements have been started to examine the detailed effect of shielding by relevant obstacles, using a coarse aerosol with drop spectrum considered most favourable for the drift spraying technique.

Spray Assessment

Use of Fluorescent Tracers: In connection with the quantative estimation of minute amounts of liquid, for example in residual spray deposits or on cascade impact slides, over 50 fluorescent tracer compounds have been examined. Of these only about six appear to have sufficient stability to light exposure coupled with high sensitivity to warrant further consideration for field use, though several others with very high sensitivity may be of use under laboratory conditions. The most stable are:

Oil Soluble	Water-Soluble
fluoresceine O.P.	fluoresceine derivatives
B-methyl umbelliferone	acridine orange
	lissamine flavine
	primulin.

With the majority of these materials, concentrations of 1 microgram/litre can be measured with an instrumental coefficient of variation not greater than 10%, while 10 microgram/litre can be measured with about 2½% coefficient of variation. Taking the former figure as the ultimate sensitivity, and using 25 cc of solvent for recovery, the amount of tracer ultimately measurable is .025 microgram. If this amount of tracer is present in 1% solution, the equivalent volume of solvent associated with such a deposit would be 2.5×10^{-6} cc.

Using the colorimetric absorption technique with a typical dye tracer, concentrations of 500 microgram/litre can be measured with an instrumental coefficient of variation of just under 10%, while 1000 microgram/litre can be measured with about 2½% error. Again, taking the former figure as the ultimate sensitivity of the method, and using 10 cc of solvent for recovery (the absorptiometer uses a smaller cuvette than the fluorimeter), the ultimate amount of tracer measurable is 5 micrograms. If this was present in 1% solution, the volume of liquid from which it was derived would be 5×10^{-4} cc.

Thus, for similar accuracy in measurement, the smallest volume of liquid required for fluorimetric estimation, with tracer at 1% concentration , is 1/200th of the limiting volume for colorimetric assay. This factor compares the relative instrumental sensitivity of the two techniques.

Comparative laboratory tests of light stability obtained by varying exposures of small droplets of tracer solution under a "sunray" lamp, showed that a measurable fluorescent loss occurred on prolonged exposure. Under the conditions of test, exposures in excess of 2 hrs. could result in a 25% loss of fluorescent reading on recovery. The exposures for an equivalent loss in direct sunlight are uncertain, but are probably at least double those indicated under the accelerated laboratory test. Using suitable field conditions losses of under 10% recovery appear quite feasible, so that the departure from quantitative recovery would be within acceptable limits for many purposes.

This work is the subject of a joint CPRU/ALRC report, (Report No. 184) and the most stable materials referred to are to be subject to final comparative field tests.

Droplet Production: A microburette of the type developed by Abberton has been constructed by the workshop staff, and is proving useful for calibrations involving droplets in the size-range 20-200/u.

Collection Efficiency of Angled-Surfaces.

Laboratory experiments have been carried out to assess the factors which determine the liquid load that an angled collecting surface can maintain up to and beyond "run-off" when sprayed with droplet spectra of various v.m.d's from hydraulic nozzles. Results have been obtained for both artificial and leaf surfaces of interest. It was found that as the v.m.d. of the drop spectrum fell from 900 to 200 there was a progressive increase in the deposit supported just prior to "run-off" at any given angle, and that the load at point of "run-off" for 200 u drops was nearly double that for 900 u drops when water was sprayed onto a maize leaf.

Following "run-off", the surface retention fluctuates as the surface drains and is re-wetted, but it is generally significantly below the maximum load supported at the point of "run-off". A slight difference was noted with maize leaves in this respect between the physiological upper and under surfaces, the fall in retention following onset of "run-off" being more pronounced for the underside. It appeared that capillary forces induced by the fine hairs on the upper surfaces of the leaf restricted the extent of run-off in this case.

Further measurements to define the effect of droplet surface tension, as determined by the presence of various concentrations of wetting agent in the liquid formulation, are proposed.

TROPICAL PESTICIDES RESEARCH INSTITUTE, ARUSHA.

ANNUAL REPORT, 31ST MARCH 1961.

Summary of Report

Work on the control of tsetse flies has continued. The aerial spraying experiment at Chungai, completed last year, proved successful and cheaper than any previous one. Preparations have now been made for a large scale field experiment, to be carried out in cooperation with the Tanganyika Veterinary Department, against *Glossina pallidipes*, by means of discriminative application of insecticides. Laboratory work on tsetse flies has been largely on variations in susceptibilities to insecticides with age, sex and species.

The use of insecticides in mosquito control has remained one of our major lines of investigation. The return of *Anopheles gambiae* and of malaria transmission into the Taveta area after the cessation of the Taveta-Pare malaria eradication scheme has been studied. Experimental hut trials on behalf of the World Health Organization to find insecticides to replace the standard chlorinated hydrocarbons when (and where) mosquitoes become resistant to them, continued at Magugu, and an interesting development in this field is the use of residual fumigants. In connection with these investigations, work is being carried out on the design of trap huts and on the habits of *A. gambiae* that effect its vulnerability to residual insecticides. The survey to discover possible resistance to insecticides in malaria vectors in East Africa has continued without any resistance being uncovered but some interesting facts on varying susceptibilities have emerged.

The work on the sucking bug of coconuts, *Pseudotheraptus wayi*, is now being brought to a close. It has shown that this insect, although it causes considerable fall of immature nuts, is not a pest of any practical importance, in that it does not cause any appreciable loss of crop in the circumstances in which coconuts are grown in East Africa.

The main effort of the Institute in the agricultural field will now be devoted to endeavouring to relate the physical and chemical assessments of insecticide sprays applied to crops to their biological effectiveness and hence finally to the yields from the crops. Initially this work will be confined to coffee, which is an important crop, attacked by many pests which are controlled by sprays. Other work in the agricultural field includes studies on the control of cotton pests and locusts.

Biting fly research continues in cooperation with the Uganda Veterinary Department at Entebbe. Papers on Laboratory investigations on *Stomoxys calcitrans* have been submitted for publication but field experiments on control measures have suffered from several set-backs.

Work on herbicides now covers a wide field, with most attention being devoted to the control of weeds in crops, although the eradication of woody species from pastures is also an important problem. With the appointment of a second botanist to this section it is hoped that some more basic work can be undertaken in addition to the present field trials.

The control of Bilharzia with molluscicides has recently been added to our programme and this work is being supported financially by the World Health Organization. Apart from direct trials of molluscicides, an important aspect of these investigations is the study of the ecology of the vector snails with special reference to sampling methods for evaluating the effectiveness of control.

Further work on fungicides awaits the appointment of a plant pathologist.

A new spraying aircraft, a Cessna 182, has been acquired and at present a considerable amount of the effort of the Physics section is being devoted to assessing the capabilities of the plane and its equipment.

ROTHAMSTED EXPERIMENTAL STATION, ANNUAL REPORT TO THE C.P.R.C., MARCH 1961.

Insecticide Pick-Up

Some particulars are given of the pick-up of dieldrin by adult *Tenebrio molitor* L., its rate of penetration into the insect and the correlation between dosage and death of the insect.

Method: Adults of *Tenebrio molitor* L. are placed on residual films of either ^{36}Cl- or ^{14}C-labelled dieldrin on glass for ½ - 2 hr., removed to clean containers for up to

11 days, and then stored at -20°C until analysed for radioactivity, by scintillation counting, outside and inside the bodies, and on the containers. Batches of insects are needed for assessment of the ^{36}Cl, and figures from such experiments are mean weights from about 15 insects, calculated as dieldrin; with the ^{14}C, single insects suffice for assessment.

Results: Insects were exposed to films of ^{36}Cl-labelled dieldrin (158/cm^2) at 25°C, and then kept at 25°C. With 2 hr exposure, the insects dying within 30 hr picked up a mean amount of 6.98 (= 5.88 inside + 1.18 outside). With 30 min exposure, those dying after 30 - 48 hr picked up 2.78 (= 2.58 + 0.28); those dying after 2-4 days, 1.78 (= 1.68 + 0.18).

In similar experiments with films of 3.08/cm^2, the insects were exposed for ½ hr. One sixth of the doses picked up (mean of 0.278/insect) had entered the bodies at the time of removal from the films, one third after 1½ hr, and two thirds after 2½ hr. One tenth was lost on the containers in 2½ hr.

When insects were exposed for 30 min to ^{14}C-labelled dieldrin films (1.58/cm^2) at 20°C, and then removed and kept at 20°C, the mortality was 50% after 11 days. The amounts outside and inside the bodies of about 150 insects, and on their containers, followed distribution patterns which were skewed towards the higher values. The mean of the amounts picked up by the insects still alive after 11 days was 0.093γ/insect, of which 7% was outside the bodies, 78% inside and 15% on the containers; and, by the insects which died, 0.132γ/insect (5% + 88% + 7% respectively). The amounts picked up ranged from 0.04 - 0.20γ/insect. There was a negative correlation between the total amounts picked up and the percentages lost on the containers.

IMPERIAL COLLEGE, ANNUAL REPORT TO THE C.P.R.C. - APRIL, 1961.

Chemoreception Studies

A general survey of the chemical senses of *Stomoxys* has been continued. Contact chemoreception in the adult is being investigated by using the rate of imbibition of candidate solutions as an index of acceptability. In preliminary experiments the rates of imbibition of solitary unfed flies from horizontal micropipettes were measured. Generally, 20 replicate experiments each lasting 20 hours were made. Some mean rates of imbibition are as follows: distilled water, 0.76 microlitres per fly per hour; 0.15 NaCl, 0.32 ul/fly/hr; 0.1M sucrose, 1.13 and 0.94 ul/fly/hr. (previously fed flies) and 0.87 ul/fly/hr. (newly emerged unfed flies.)

In an attempt to find a technique involving less manipulation the feeding rates of groups of flies contained within permeable cellophane bags is being studied. 6 groups of 20 flies over a period of 22 hours had a mean imbibition rate per fly per hour of 0.57 microlitres of 0.1 Molar sucrose solution.

Contact chemoreception in the larvae is also being briefly investigated. In experiments with solitary larvae in choice chambers in dim light at 25°C, thresholds of response to hydrochloric acid were found to lie between 0.1 and 0.01 Molar concentrations, to sodium hydroxide between 0.5 and 0.1 Molar, and to sulphuric acid, below 0.0125 Molar. Sucrose solution had no effect at molar concentration.

Work on the olfaction in adult *Stomoxys* has been held up pending the further development of a flame ionisation detector for monitoring concentrations of stimulant in air streams.

A detailed study of the gustatory receptors of the proboscis of *Stomoxys* is in progress. On the labella, there are approximately 80 receptors, 30 of them distributed in 3 groups on the outside of each end lobe and 28 in a series lying at the extreme tip when the labella lobes are closed. All these are double channelled setae with nerve fibres running to the extremity of the inner compartment and thus similar in structure to the gustatory setae of the blowfly. In addition, there are 20 short, blunt, thick-walled receptors lying adjacent to the teeth and exposed only when the proboscis is spread for probing. These also have 2 compartments and are innervated.

The primary interaction between stimulant molecules and a receptor occurs at a papilla on the extreme tip of the organ, and the fine structure of this region is now being investigated using electron microscope techniques.

Mode of Action Studies in progress at Silwood park have already been reported in PANS, 1961, 7, (1), 90-91.

MINISTRY OF HEALTH MALARIA SERVICE, YABA, LAGOS, NIGERIA, ANNUAL REPORT FOR 1960.

Fly Control

The control of flies is essentially a hygiene matter, the only effective means being the prevention of breeding by correct refuse disposal, but on a short term basis local control can be obtained by the use of insecticides,

Two treatments have been found useful: Fogging by means of a "Swing fog" applicator, (for a rapid knock-down), and a residual spray consisting of malathion 25% w.p. (2lb) with sugar (2½lb) in water (2½gal) for application from a pneumatic knapsack sprayer to infested sites. The latter has been described as an effective shock treatment.

Mosquito Control

The expedient of dosing soakage pits with insecticides has been tried in several pits breeding *Aedes aegypti* and *Culex fatigans* at Yaba. BHC emulsion, "Phosdrin" emulsion and malathion emulsion and wettable powder have all been found only partially successful. This is due to the fact that most soakage pits are infested with rats, so that there is a labyrinth of water logged burrows all round them, and insecticide applied by flushing does not reach the breeding sites.

Insecticide Resistance Reference Laboratory

Work has consisted of the development of a new method of examining the kinetic effects of insecticide exposure, with a view to the investigation of the phenomenon of behaviouristic resistance.

WHO/Insecticide Testing Unit

For the sole purpose of obtaining effective new insecticides to replace those of the chlorinated hydrocarbon group to which Nigerian mosquitoes and those elsewhere have built up resistance, the WHO established an Insecticide Testing Unit at the Nigerian Federal Malaria Service. The Unit has received valuable assistance from the Malaria Service both in manpower and in entomological and parasitological assistance.

The compounds tested in 1960 have been "Baytex" and malathion wettable powders, both organophosphorus insecticides known for some time but not previously tested on a pilot project scale in Africa. Five villages were selected on a basis of anopheline density, convenient size, and co-operative population, and sprayed with "Baytex" at 1 g/m^2, and 2 g/m^2, malathion and DDT at 2 g/m^2, the fifth being left as an unsprayed control.

The methods used to assess the value of the compounds have been weekly use of window exit traps in twelve houses per village; weekly spray-sheet catches in the same station, bio-assay of sprayed surfaces using *A. gambiae* bred in the laboratory, and chemical assay of the same surfaces.

Both of the OP compounds have shown prolonged insecticidal activity on non absorbent surfaces such as wood palm tile, and palm-leaf mid-rib. On mud, malathion has not produced sustained activity, but "Baytex" has performed very well so far on this surface too.

Kinetic Activity of Mosquitoes.

An apparatus has been devised for measuring the kinetic activity of mosquitoes in the presence of, or after having been in the presence of, insecticides. The final model consists of 4 boxes 12 x 12 x 15 cm. interconnected by baffles which bias mosquito movement in one direction. The mosquitoes are placed in box 1, and the degree of activity can be measured by the number of baffles passed. The degree of activity is best measured as a percentage of the total possible, according to the formula.

$$\frac{(n_2 + 2n_3 + 3n_4) \times 100}{n_1 + n_2 + n_3 + n_4)^3}$$

where n_1, n_2, n_3, n_4 are the numbers found at the end of the trial in each box. The activity was measured under three sets of conditions, viz: continuous exposure to insecticide treated paper lining box 1: exposure immediately before being placed in the apparatus; exposure followed by an interval before being placed in the apparatus.

Results with various insecticides are summarised below:

DDT : Immediate increased activity, lasting for some 5 hours after sublethal contact, followed by a period of decreased activity.

Dieldrin: Increased activity after a latent period of about 5 hours not so intense, but lasting longer than that caused by DDT, up to 13 hr. after exposure.

Malathion: Decreased activity for 5 hours, followed by an increase, sustained for at least 13 hours.

Baytex : An immediate increase in activity, but not so intense as with DDT.

Culex fatigans, a much less active insect, shows similar effects except that the decrease in the early stages of malathion intoxication cannot be detected. Early activity is greatest with DDT, least with dieldrin.

The question arises as to whether the activating effects of DDT may be modified by the use of a DDT/malathion mixture. There is evidence that this is so, and that even a 1 : 4 malathion/DDT mixture is as lethal as malathion alone, and much more lethal than DDT.

It is thought that an apparatus of this kind, in which can be studied not only the activity caused by insecticide exposure, but also the mortality in mosquitoes free to leave the treated surface, may be of use in the interpretation of field data on mosquito behaviour in the presence of insecticide treatments.

Parasitology

The year 1960 was one of concentrated activity on malaria surveys and control.

THE PERSISTENCE OF DIELDRIN RESIDUES ON NON-SORBENT SURFACES WITHIN BUILDINGS

G.F. BURNETT. Tropical Pesticides Research Institute, Arusha, Tanganyika. Miscellaneous Report No. 290. April 1961, pp6, refs., tables 3, figs. 2.

"In Fiji", states the author, "it was found that dieldrin residues on matting kept in houses treated with dieldrin were lost at a rate inversely proportional to the initial deposit (Burnett 1960). A possible reason is that volatilisation is reduced by a high vapour pressure due to the heavier deposits. It was decided to check the finding and to test this hypothesis by exposing identical panels in huts with an available supply of dieldrin for volatilisation and in others with none".

The general procedure and conclusions are summarised as follows:

Strong brown paper panels were sprayed with dieldrin emulsion and with wettable powder at 3 rates and placed in huts treated internally at 3 rates. It was intended that these should be the same as that of the panels, but owing to an error of procedure the w.p. was applied at half the intended strength. The final arrangement was that a pair of huts treated at 35 mgm/sq. ft contained panels treated at 35 mgm/sq. ft with emulsion and at 35 and 17.5 mgm/sq.ft with wettable powder, a pair treated at 70 mgm/sq. ft contained panels of both formulations at this rate and a pair treated at 140 mgm/sq. ft contained only emulsion-treated panels. One of each pair of huts was lined with strong brown paper, the other with highly sorbent plaster. Residues were estimated chemically at intervals and their toxicity measured by bio-assays with mosquitoes.

Regression lines for residues against time were estimated by converting deposits to mean log. values and plotting against days after treatment, on a linear scale.

Wettable powders gave straight lines and were 100% lethal to test insects (exposed for 1 hour) many weeks after the residues were too small for chemical estimation. It may be noted that the wettable powders were highly lethal many weeks after residues were too small for estimation. Emulsions showed a flattening-out of the curve when about 1/10th of the initial deposit remained and caused less than 100% mortality when as much as 24 mgm/sq. ft was estimated to remain. This is probably because the insecticide remaining was embedded in the fibres of the paper, whereas the wettable powder was all on the surface. For this reason the two formulations cannot be compared. Regression lines for those deposits were calculated for the straight portions only.

Taken separately, both formulations were consistent in persisting longer in paper-walled houses, i.e. with a large surface of dieldrin exposed to volatilisation. The vapour produced might be expected to reduce loss by sublimation from the paper panels. However, a significant difference was demonstrated only in two cases, wettable powders at 70 mgm/sq. ft and emulsions at 140 mgm/sq. ft.

Taking each formulation separately, there is a strong, consistent and significant tendency for heavier deposits to disappear at a lower rate. e.g. wettable powder at 17.5 mgm/sq.ft in a paper-lined hut took 55 days to fall to 25% of the original value whereas at 70 mgm/sq.ft in a similar hut it took 92 days to fall to 25%. Both treatments still gave 100% mortality with *A. gambiae* exposed for 1 hr after the residue was below 2 mgm/sq. ft, below which level it could not be estimated accurately. The two treatments took 96 and 248 days respectively to reach it.

DOSAGES IN EXPERIMENTAL HUTS

D. YEO Tropical Pesticides Research Institute, Misc. Rep. No. 292 June 1961 pp.2, 1 Table 3 Figs.

Improvements in application and sampling procedures have justified the expectations made after a preliminary assessment (Misc. Rep. 286).

On this occasion the mean dosage was 1.50 g/m^2 which, after allowances had been made for a 25% loss between nozzle and the surface, was not different from the expected dosage.

No significant differences were revealed between the dosages of various sectors.

TOPICAL APPLICATIONS OF INSECTICIDES TO TSETSE FLIES
IV ORGANOPHOSPHORUS COMPOUNDS, PYRETHRINS, AND SEVIN TO GLOSSINA MORSITANS. WESTW. AND BAYTEX TO GLOSSINA SWYNNERTONI AUST.

G.F. Burnett. Tropical Pesticides Research Institute, Arusha, Tanganyika.
Miscellaneous Report No. 289.

A variety of organophosphorus insecticides, "Sevin", pyrethrins, and pyrethrins synergised with 15 parts of piperonyl butoxide have been applied topically in solution to young *G. morsitans*, and "Baytex" has also been applied to wild *G. swynnertoni*.

Because many organophosphates and also "Sevin" are not readily soluble in kerosene, the organophosphates were applied in dekalin (decahydronaphthalene) which is non-toxic in the amount used and in its physical properties sufficiently close to kerosene.

Malathion, methyl parathion, DDVP and "Sevin" were too ineffective for detailed study and "Muscatox" was rejected because of its poor solubility.

"Baytex" was the most toxic organophosphorus compound evaluated, being 2.3 times as effective as diazinon and not significantly different from gamma-BHC, but significantly less toxic than dieldrin (2.8 times). It was only slightly more toxic to wild *G. swynnertoni* than to laboratory reared *G. morsitans*. Wild female *G. swynnertoni* were just significantly more tolerant to this insecticide than were the males.

Synergised pyrethrins were less toxic to females than to males but only 2.3 - 1.6 times more toxic than unsynergised pyrethrins, which were about as toxic as dieldrin.

Diazinon approximates to DDT in its toxicity to *G. morsitans* but the regression lines are not parallel and LD 50's cannot be compared. It may be noted that the difference between males and females to diazinon (1:1.4) is the first significant sexual difference detected in this series of experiments.

INSECTICIDE INVESTIGATIONS AT WEST AFRICAN TIMBER BORER RESEARCH UNIT.

Fourth Report of the W.A.T.B.R.U. 1961.

Insecticides (F.G. Browne).

Numerous investigations in previous years, made by both this Unit and other organizations, have demonstrated that benzene hexachloride is superior to any other known preservative, applied to the surface of logs and lumber, for the prevention of attack by ambrosia and powder-post beetles. It is therefore now the policy of the Unit to restrict investigations to various formulations of benzene hexachloride - particular attention being given to persistence and resistance to wash-off by rain or in rivers or, of course, to entirely new insecticides.

During the year a small preliminary trial was made of a reputedly new insecticide, still on the secret list. It was tested at a concentration of 0.75%, as emulsions in both oil and water, during 6 weeks of rather rainy weather in a forest near Kumasi, and was compared with benzene hexachloride (0.75% gamma concentration in oil) and with untreated controls. All treatments gave a high degree of protection to the test billets against ambrosia beetles, and although the new insecticide billets showed slightly heavier superficial infestation than those treated with benzene hexachloride, the difference was slight and no breeding occurred. It is considered that in this one small test the new insecticide gave a promising performance, and is worth more extensive trial as a possible alternative to benzene hexachloride. Further tests of a paint formulation of benzene hexachloride had unfortunately to be postponed for various reasons, but it is hoped that it will be possible to test it on floating logs in Nigeria during the rainy season of 1961.

Timber Protection at Harbours. (Hywel Roberts)

The following recommendations refer particularly to Takoradi Harbour but probably apply equally well to timber exported through other harbours in the tropics.

1. Logs

(a) All logs of susceptible timbers (chenchen, mahogany, emeri, wawa) should be sprayed with a gamma-BHC oil or water miscible formulation, strength 0.75% active ingredient, preferably at the felling site or at the latest in the timber yard. Such treatment will prevent attack by pinhole borers.

(b) Every effort should be made to ensure that logs of susceptible species are shipped within one week of being put into the water. Logs that are delayed in shipment, should be examined once each week for attack and should be re-sprayed at the first signs of new infestation.

(c) Old "reject" logs should not be allowed to remain for any length of time on wharves or in the water of the harbour.

(d) If it is possible to submerge the floating logs of susceptible species attack would be greatly reduced. However the techniques required to handle and store large numbers of submerged logs may limit the practicability of this as a solution to the problem.

2. Lumber

(a) All lumber of susceptible timbers (wawa, emeri) should be dipped, or sprayed with a 0.5% gamma-BHC wettable powder, or water miscible formulation, on cutting, or immediately after stacking in the yard. If kept in stack for longer than 4 weeks the lumber should be re-treated prior to removal to the port.

(b) Regular weekly inspection of the storage sheds in the harbour is essential and any stacks found to contain powder-post beetles should be opened and infested boards destroyed. Should heavy infestation occur, one spray treatment of the whole shed should be made.

(c) Regular weekly inspection of "dunnage" used in the stacks is essential. Always, if possible, "dunnage" should consist of heartwood only. Susceptible timbers such as wawa should never be used.

(d) Stacking of lumber in sheds should be done in such a manner that all parcels can be easily reached. "Forgotten" parcels are particularly bad centres of infestation.

(e) As with logs, no accumulation of old boards or "sticks" should be allowed in the harbour area.

COTTON PEST RESEARCH AT GATOOMA. QUARTERLY REPORT, JANUARY-MARCH 1961.

Diparopsis

New carbamate insecticide: A new carbamate insecticide known by the code NC 930 has been shown to be as toxic to *Diparopsis* eggs as "Sevin". It has, however, a much higher mammalian toxicity.

Use of "Sevin": The mean larval wandering period before death on plants sprayed with Sevin 85S at 0.5% a.i. with a 'tailboom' has been shown to increase considerably when the plants have been subjected to ½" or more rain. The intensity of rain also affects the persistence of the deposits of "Sevin". The wandering period on plants kept in the sunlight, but protected from rain, increased slightly over a period of fourteen days. For plants kept under laboratory conditions the period hardly increased over a period of thirty-six days. "Sevin" does not exhibit any systemic effect on larvae present in buds at the time of spraying. A few young larvae are killen when exhibiting "re-entry" movements within the bracts.

"Sevin" is remarkably resistant to loss due to U.V. light, evaporation and decomposition, but is readily washed from the cotton plants by rain. The addition of special formulants or stickers is being investigated, but as yet no satisfactory economic additive has been found.

Other Insecticides: "Rogor" exhibited a slight systemic effect against 1st instar larvae when sprayed to "run off" at the rate of 1% ai. "Thiodan" showed a similar effect to "Sevin".

Effect of New Growth: It has been shown that with small plants, the increase of leaf area over a period of seven days necessitates spraying at least weekly to obtain maximum control at this stage of plant development.

Heliothis

The wandering period before death of 1st instar *Heliothis* on plants sprayed with "Sevin" is similar to that shown by *Diparopsis*, except the larvae frequently rest for considerable periods. On unsprayed plants larvae will take over five hours before entering a bud of which only two to three hours is taken up by wandering.

Using 10 day old *Heliothis* larvae with single plant tests it has been shown that DDT gives better control than "Sevin", especially where the larvae are already infesting the buds and bolls at the time of spraying. "Sevin" gave good control of 1st instar larvae and 10-day larvae if the plants were infested immediately following spray. If 1" of rain fell on the plants before infestation with 1st instar larvae, the effectiveness of "Sevin" was considerably reduced in contrast to DDT which remained effective after 1" rain.

Dysdercus: Tests show that "Sevin" 0.5% applied at 10-20 gal per acre gave excellent control of *D. fasciatus* and *D. intermedius* adults. Following heavy rain, there is negligible control of adults caged on leaves.

RESEARCH AT WELLESBOURNE, BIOASSAY OF SOIL INSECTICIDE RESIDUES.

G.A. WHEATLEY and J.A.HARDMAN. National Vegetable Research Station, Wellesbourne, Warwick. Eleventh Annual Report 1960.

Continuous use has been made during the past year of a sensitive bioassay method for estimating residues of certain chlorinated hydrocarbon insecticides in soils. Residues of dieldrin and heptachlor present in the soils of a number of long term field experiments on the control of carrot fly have been assayed. The results have confirmed the extreme persistence of dieldrin in soil in England.

Error Components

Further studies on the error components associated with the bioassay technique have shown that errors in assaying soil samples in the laboratory are similar in magnitude (about 7-10% of the means)to those involved in obtaining soil samples from field plots. Therefore, the standard errors for estimates of residues in field plots are about ± 10-14% of the mean values and it seems unlikely that this can be much reduced with the methods available at present. Since the rate of loss of dieldrin is equivalent to about 15% per annum, it is impossible to obtain significant differences between the amounts present in two consecutive years, although it will be possible to estimate trends of residues over a number of years and thereby obtain the necessary information on average rates of loss.

Build-Up of Residues

Where a crop such as carrots is grown intensively in short rotations, insecticide may be re-applied by growers when appreciable amounts of earlier applications still remain in the soil. Thus there is a danger of residues accumulating to undesirable levels when a persistent material such as dieldrin is used. Although insufficient time has elapsed to establish whether and to what extent this 'build up' may occur in practice, theoretical considerations suggest that the residue level for a given insecticide should tend to reach a maximum value which will depend on soil conditions, dose and frequency of application. It has been possible, however, to calculate a sliding scale of reduced doses for dieldrin shown in the table, based on the dose and frequency of application (crop rotation length), required to restore the concentration of dieldrin (half-life four years) in the top four inches of soil to the desired value for carrot fly control. The use of this interim recommendation should prevent excessive residues occurring until such time as more precise information can be obtained.

Amounts of Dieldrin (lb per Acre) Required to Restore the Concentration in the Top Four Inches of Soil ∅

Initial Dose lb/acre	Interval Between Applications, Years					
	1	2	3	4	5	6
0.75	0.4	0.5	0.5	0.6	0.6	0.6
1.5	0.9	1.0	1.0	1.1	1.2	1.2

∅ Reproduced from Plant Pathology, 9, 148.

Determination of Mixtures

Bioassay methods are non-specific because the responses of the test organisms do not identify the toxic compounds involved. These methods, therefore, are only suitable when the identity of the toxic residue is known beyond reasonable doubt, or when it is sufficient to know that samples do or do not contain biologically active components. It is now well known that many of the chlorinated hydrocarbon insecticides change to varying extents into allied biologically active compounds after application. For example, aldrin and heptachlor become epoxidised to form dieldrin and heptachlor epoxide respectively and, whenever either of the two former compounds are used, their residues are inevitable mixtures containing the appropriate epoxide as well as the parent compound. The components of such mixtures cannot be readily measured by biological methods alone. On the other hand, chemical methods specific for the parent compounds do not detect the biologically active derivatives and this leads to underestimates of the amounts of active residues present. Paper partition chromatography, however, offers a means of detecting, identifying and semi-quantitatively estimating small amounts (1-2-ug) of chlorinated hydrocarbon compounds. A preliminary study has shown that this technique can be applied to residues in soils but difficulties have been encountered in the attendant extraction and 'clean-up' procedures when residues are less than about 0.1-0.2 p.p.m. Attempts are being made to improve the sensitivity and range of the method so that it can be used in parallel with the bioassay technique to provide more precise data on residues. Furthermore, where complex mixtures of insecticides occur, as in soils which have been treated with several compounds, paper chromatography appears at present to be the only practical way of assessing residues.

THE USE OF FLUORESCENT TRACERS IN THE DETERMINATION OF SMALL AMOUNTS OF INSECTICIDAL SPRAYS.

D.R. JOHNSTONE and D.J. BERRYK, Tropical Pesticides Research Unit, Porton, Report No. 184, and Anti-Locust Research Centre, Porton, Report No. 1/61

The need for accurate estimates of spray volumes considerably less than 10^{-4}ml. has given rise to experiments with fluorescent tracers.

Over 50 substances have been examined in the laboratory with regard to stability, sensitivity, actinic stability and availability.

Some measurements were made in a Dowdall and Stretch twin beam nullpoint filter type fluorimeter and others in an Aminco-Bowman spectrophotofluorimeter. Accelerated light exposure was obtained with a "Sieray" lamp unit.

None of the materials examined were entirely stable to light exposure but the following are considered sufficiently stable and sensitive for field testing.

Oil Soluble	Oil Colour 7G B-methyl Umbelliferone
Water Soluble	Fluoresceine Extra, LTS. Acridine Orange. Primulin. Lissamine Flavine.

The authors note that the fluorescence of the oil soluble materials is generally more readily reduced by light exposure, and with the exception of B-methyl umbelliferone, is unmarked by changes of pH.

It is recommended that when recovery of tracer is to be made from living surface tissue, especially if an organic solvent is being used to take up an oil-soluble tracer tests should be made for interference by native soluble fluorochromes, and a blank correction established, if necessary.

INVESTIGATION INTO THE FACTORS AFFECTING UNDERLEAF COVER USING THE BOOM AND NOZZLE CROP SPRAYING INSTALLATION FITTED TO THE DRAGONFLY HELICOPTER

D.R. JOHNSTONE. Tropical Pesticides Research Unit, Porton.
Report No. 183. April 1961.

By way of introduction the author states: "One of the main distinctions between the performance of the helicopter and the fixed-wing crop sprayer, is the enhanced amount of "underleaf cover" attributed to the former machine. This effect has been considered as resulting primarily from the high velocity airstream of the rotor down-draught which may act in a number of ways. Thus, if the airstream is sufficiently turbulent, small droplets may be caused to swirl upwards as well as moving outwards from the emission point. Further, it has also been suggested that the airstream may be reflected upwards on approaching the ground, carrying with it at least the finer droplets in the spray. A more likely cause appears to be the high degree of movement induced in many types of crop by the passage of the airstream, when violent fluttering of leaves may expose both their sides intermittently to the direction of the impressed air, with resulting bilateral deposition. It was desired to show which of these causative factors predominated in conventional helicopter spraying (with boom and nozzle equipment giving v.m.ds of 180-300 u), and also the necessary operating conditions for maximum effectiveness in producing "underleaf cover"."

The current field investigation employed artificial targets in an attempt to restrict the number of variables, and to simplify interpretation of the results. Quantitative assessment was obtained by measurements of the relative deposits received on opposing faces of rigid and flexible collectors mounted in a single line layout at heights of 6" and 36" above ground level, for various aircraft height/speed combinations. The final stage of the investigation requires that the conclusions reached by the use of artificial targets be verified directly in a crop.

Conclusion

The amount of under-surface cover obtained under these conditions was determined largely, but not entirely by flexibility of the target. It was only at low height/speed combinations (less than 20 ft/30 m.p.h.) and in particular with the finest drop spectra employed, (viz 180 u v.m.d.) that undersurface deposition became appreciable, and it appears that rather finer drop spectra, of v.m.d. say 100-150 u would be more effective in increasing this type of deposition.

Further to his results the author notes: "It appears that the flexible horizontal targets achieve enhanced collection by virtue of their motion, which causes them to send a high proportion of their exposure time with a much increased projected target area normal to the direction in which the droplets are being carried. However the fact that quite significant deposition was measured on the underside of the rigid horizontal targets indicates that a proportion of spray droplets are swirled upwards, either in local turbulent eddies in the rapid laterally moving air, or in reflected air currents".

A further feature of the trials, for which comment is invited, is the variation of the relative deposits on windward and leeward faces of the vertical targets across the layout.

Spraying

Use of Fluorescent Tracers: Visual assessments of cover on tree surfaces have been made using fluorescent dyes, fractions of the surface area of individual buds, leaves, or fruit being put into categories defined by levels of cover on specimen buds, etc. These standard deposits were photographed and the amount of material contained therein estimated by colorimetric and chemical means. The subjective errors in such a visual assessment may be relatively high but it has the advantage that two observers can deal with about 1000 samples in half a day and the human eye can readily discriminate between abnormal areas of deposit, e.g. on dead leaf tissue, and a normal pattern. Further analysis of results will give information on the accuracy of the method, but it is expected that the reduction in sampling error, made possible by the rapidity of the method, will far outweigh the subjective error when the technique is compared with any practicable method of measurement by instrument. The use of these dyes in conjunction with regular applications of fungicide and insecticide will define the deposits obtained from the treatments for correlation with the biological results.

Range Measurement: The relationship has been established between the range of a drop of water and its size and initial projection speed. The simplified form of the results is

$$S = \left(\frac{d\sqrt{v}}{50}\right)^{1.5}$$

where S = distance, cm; d = drop diameter, u; and v = drop speed, m/s. For example a 150 u drop moving at 16 m/s achieves a range of 41 cm. An elementary idea about avoiding all drift from aircraft is, accordingly, to have all the spray drops larger than 150 u and have the distance between the nozzle and the crop less than 41 cm along the path of the drop.

The latter requirement is one of the factors leading to interesting conclusions about aeroplanes used for agricultural purposes in areas with predominantly small fields, for example Western Europe. There is an obvious and important need in such a situation for a new type of aircraft such as an autogyro or an even simpler unit which would presumably take the form of a ducted fan. The Department is co-operating in the development of such a unit.

CONTROL OF COCOA CAPSIDS IN WEST AFRICA.*

A.J. VERNON. Statistics Department, Rothamsted Experimental Station,
Harpenden, Herts.

In view of the forthcoming Cocoa Alliance Conference** a summary of the increases in yield of cocoa in West Africa following insecticidal spraying to control capsids, and of the relative merits of γBHC and aldrin is of interest. The results available are from an experiment in Nigeria[1], recent trials in Ghana[2,3], and an unreported trial by the Shell Co. of Nigeria and the Ministry of Agriculture W.R. Nigeria. This account has been agreed with the people and organisations responsible for the experiment. Permission to use unpublished data is gratefully acknowledged.

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* This communication has been reproduced from Chemistry and Industry, dated 5 August, 1961 with the kind permission of author and editor.

**Cocoa, Chocolate & Confectionery Alliance Conference, 1961 (London September 12-14).

In Table I the yields of those trials in which they were recorded are given. In the Shell trial each treatment consisted of three applications as follows:

γB.H.C.: 4 oz. per acre as Gammalin 20 in Aug., Sept., and Oct. 1959.

Aldrin (a): 4 oz. per acre as Aldrex 40 in Aug., Sept., and Oct. 1959.

Aldrin (b): 4 oz. per acre as Aldrex 40 in Aug., 2 oz. per acre in Sept. and in Oct. 1959.

Details of the treatments in the other two trials have been given elsewhere.[1,3]

Pods are not picked until more than 20 weeks after pollination so their numbers in the first few months are presumably unaffected by treatment: consequently the yields of the two Nigerian trials have been adjusted by regression on the yields of the first 20 weeks. The Ashanti data could not be treated in this way.

The standard errors show that these trials are insufficiently sensitive to detect relatively small differences such as those between aldrin and γB.H.C. or the response to treatment when capsid attack on the control plots (as in the Shell Trial) is only slight. Such differences may be of practical importance, because a yield increase of only 4% can more than cover the cost of treatment.

The great variation in response to insecticide from trial to trial (from 10% in the Shell trial to 110% in Ashanti) is largely associated with variations in initial canopy condition. Without a regional survey of a canopy variation these results therefore give no indication of the yield increases obtained over West Africa as a whole; but it has been suggested by Holmes,[4] arguing from the increases in total production in West Africa since 1957, that these are well over 50%. This is in agreement with estimates made before 1954 of the losses caused by capsids (e.g. ref. 5, 6) and the fact that almost complete suppression of these pests is now being reported from Ghana and Nigeria.

In the absence of reasonably precise yield figures, aldrin and γB.H.C. can be compared only in terms of relative capsid kill. Table II is based on S the number of shoots (per 100 trees) newly damaged by capsids, recorded monthly; and Table III on the number of trees (per 1000) newly damaged by capsids, recorded fortnightly and added in pairs to give monthly total T. Logarithmic transformations have been used.

Table I

Yield in year starting five months after initial treatment

	Nigeria 1956-7[1] *pods per 100 trees*	*Ashanti 1958-9*[3] *pods per acre*	*Shell Trial pods per 100 trees*
Control	469 (± 62)	3120 (± 1130)	1426 (± 167)
B.H.C.	621 (±36)a	5920 (±800)b	1682 (± 167)
Aldrin		7200 (± 1130)c	1452 (- 118)d

(a) The mean of those treatments with 8 sprayings at 4 oz. rate or two such sprayings and spot re-treatment.
(b) The mean of a 2 x 4 oz. initial application, 2 x 1 oz. re-treatments, and 2 x 2 oz. initial application, 2 x 1 oz. re-treatments.
(c) 2 x 4 oz. initial application, 2 x 2 oz. re-treatments.
(d) The mean of the 2 aldrin treatments.

Table II

Shell Trial: Capsid damaged shoots (means of log $(S + 1)$ in various periods)

	Months after initial treatment		
	1-3	4-7	8-10
Aldrin (standard rate)	1.20	1.27	0.59
Aldrin (low rate)	1.08	1.27	0.90
γB.H.C.	1.49	1.17	1.09
Control	1.81	2.17	2.07
Standard Error	±0.15	±0.09	±0.11

There were some slight variations in rates of application but for practical purposes the aldrin and γB.H.C. figures in Table III can be taken as representing equal rates of active ingredient. No significant differences appear between aldrin and γB.H.C. in the detailed results of the two trials except those seen in the pooled results, namely the relative superiority of γB.H.C. in the three months following the initial treatment and in the first recorded (2nd actual) month after each spraying. The significantly lower figure for aldrin in the final period in the Shell trial is supported by the tendency in the few records made more than seven months after spraying in the Ghana trials for the aldrin figures to be lower than those of γB.H.C. There is, therefore, evidence that aldrin may give longer control; but in view of the suggestion that γB.H.C. may have a greater immediate effect there seems on balance to be little to choose between them in terms of capsid control.

TABLE III

Joint WACRI/Ghana Division of Agriculture Trials[7]*: Capsid damaged trees*

Pooled results of 1957-8 trials in Eastern Region & 1958-9 trials in Ashanti

(a) Mean log $(T+1)$ for periods between treatments (sprayings in July, Nov. & July 2nd year)

	Aug.- Oct.	*Jan.- May*	*Aug.- Nov. 2nd year)*
Aldrin	1.24	1.11	0.49
γB.H.C.	0.60	0.97	0.50
Control	1.56	1.60	1.31
Standard Error	±0.10	±0.11	±0.10

(b) Mean log $(T+1)$ pooling all periods, classifying by No. of months from spraying or re-spraying.

	Aldrin	*γB.H.C.*	
2nd month after spraying	0.77	0.35	) Interaction significant at 2% probability
3rd month after spraying	0.90	0.65	)
4th month after spraying	0.98	0.81	)

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REVIEW ARTICLE

Report on a Visit to Africa 7.5.60-2.7.60.

by

H. S. Hopf

Scientific Secretary, Colonial Pesticides Research Committee.

Introduction

During May and June 1960 I visited the territories of Tanganyika, Zanzibar, Kenya, Uganda and Nigeria under the auspices of the Colonial Pesticides Research Committee. Having only recently entered on my present duties, and having never before visited Africa, I regarded it as my primary object to see as much as possible of all aspects of tropical pesticidal research and to meet as many as possible of the workers engaged in it. In addition, I had the opportunity to see much work in allied fields, and I was anxious on all occasions to get a first-hand impression, however, superficial, of the social and economic background against which research is carried out. My attention was not confined to the scientific and technical problems I encountered, but I have also tried to learn as much as I could of the organisational and financial aspects which pose such great difficulties in present-day Commonwealth Africa.

At first the intention had been to confine the visit to East Africa. At the request of the World Health Organization, the Colonial Office then agreed to let me visit Nigeria as well, in order to report to W.H.O. on their recently-established Insecticide Testing Unit in Yaba, and I naturally took the opportunity to see other pesticidal research, but time did not allow me as wide a scope as in East Africa, and my visit to Nigeria was very much biased towards Medical Entomology.

A detailed itinerary is attached at the end of the present report. 51 research establishments and government departments were visited, and discussions were held with nearly 200 scientists and administrators (not all of whom are named in the itinerary). Apart from C.P.R.U., Arusha and I.T.U., Yaba, where detailed discussions took place with every available staff member, visits were usually confined to a few hours, and only superficial impressions of the work in progress could be obtained.

Under these circumstances little useful purpose would have been served by a detailed account of my safari, especially as all places visited are on a well-trodden path, more familiar to most readers of this report than to myself. Instead, I thought a certain amount of interest could be aroused by some brief notes on the progress of work in three major fields, which are not only of basic interest to tropical economy, but also characterised by much topical development. These problems are (a) Coffee, (b) Tsetse, and (c) Malaria. The basis of selection was that pesticidal research on each of them is widespread, and that there is much divergence of opinion on some aspects of this work. In the following notes, views attributed (it is hoped correctly) to certain research workers are not necessarily those of the author of the report.

I cannot hope to list all those whose kindness and hard work have made my tour so interesting and personally enjoyable. I trust I may be permitted to express in general terms my deep indebtedness for all the help I have received from the Governments of all five countries concerned.

COFFEE

Coffee is becoming an ever more important cash crop to the East African cultivator. Family labour is cheap, and little, if any, investment in machinery is required. Most *arabica* coffee is grown in the White Highlands of Kenya, but even in that country the African share is increasing (25,000 acres now). In Uganda all and in Tanganyika most of the coffee cultivation is African, chiefly of the *robusta* kind. These two species account for all the coffee grown, though I have seen some experimental plots of other varieties on the Tanganyika coast.

C.P.R.U. Arusha are planning a programme of investigation into the fundamental principles of pesticide applications, using coffee as a model crop. Mr. McKinley will be co-operating with the agricultural departments of the territories, fitting in with their programmes. It is hoped that C.P.R.U. will carry out the agreed treatments and the physical and chemical assays, while the local stations will be responsible for the biological results. The pests of greatest interest for this programme are *Antestia*, various leaf-miners of the genus *Leucoptera*, and the coffee rust *Hemeleia*. An example of the lines of thought is provided by the follow-up work to experiments undertaken in co-operation with Jacaranda Coffee Research Station. Then Perenox had been sprayed at 3 constant rates per acre in 7, 60, and 120 gallons/acre, and an assessment made by filter papers sprayed with dye. This gave more deposit for high volume than for low volume, and more on the upper surface than the lower. But the opposite result was obtained by chemical assessment of treated leaves. Apparently the explanation is found in the greater run-off from the non-absorbent plant leaves at high volume. The top of the leaf is more waxy than the lower surface, and more runs off. Biological results were not yet available at the time of my visit. It is now intended to try several types of machinery at a wide variety of volumes and constant dosage of the active principle to establish the exact point where wastage begins in conjunction with Mr. Yeo. To this end model experiments with artificial surfaces, such as table tennis balls and drinking straws are already in progress at Arusha. Comparisons of aircraft spraying with the L.A.M.B. are also planned.

One of the most important weeds is Nutgrass *(Cyperus sp.)*, and Mr. Hocombe has been trying nine triazine weedkillers. Six of these have damaged the coffee, but simazine looks good. Further trials are envisaged, including eptam, which had previously failed on wet soil, but done well on dry.

Another problem of interest to Mr. Hocombe is the alleged liberation of substances toxic to coffee by couch grass killed with dalapon. He is planning pot experiments, using a bio-assay method on the leached water to investigate the possibility.

At Lyamungu Coffee Research Station, Mr. Tapley is studying complex factors causing leaf fall, which he regards as the most important problem awaiting solution. The factors are both fungi *(Hemeleia)* and insects (chiefly leafminers) and control by copper and parathion has so far not been satisfactory. If there is satisfactory control, yields may be raised from 4 cwt./acre to 10 cwt./acre, with a further increase to be obtained by judicious application of N, P, K and Mg. He wishes to concentrate on a study of the biocenosis and ecology as a result of spraying over a number of years, and would be glad to leave to C.P.R.U. all pesticidal application problems, including the biological assessments. He is particularly perturbed by the use of chlorinated hydrocarbon insecticides on leafminers, as these destroy the parasites and therefore lead to an increase of the pest. Parathion is better but cannot be used by the peasant-cultivator because of its high toxicity. The need is for a cheap, non-persistent insecticide of low toxicity to mammals and harmless to parasites. Apart from parathion, the phosphoric esters tried were either useless or too expensive.

The following results of an experiment on unshaded coffee illustrate the complexity of the problem:

Leaf miner only controlled by parathion	3 cwts./acre yield
Hemeleia only controlled by copper	8 " " "
Both controlled	10 " " "
Untreated	3 " " "

Mr. A. Melville, Chief Research Officer in the Kenya Ministry of Agriculture, was very appreciative of the help he has received from C.P.R.U. in the past. Coffee cultivators are the main users of pesticides in Kenya. He hopes to see a rapid expansion of co-operative societies of African coffee growers, which would help to make peasant-cultivators use pesticides. The societies would supply the chemicals and train teams for their application, but many more Field Officers etc. would be needed to supply the necessary skills.

Some interesting experimental results were related by Dr. F.J. Nutman and his colleagues of the Coffee Berry Disease Unit stationed at the Scott Laboratories, Nairobi. They claim to have established that *Hemeleia* cannot be dispersed by wind at all, but only by water. It can therefore be eliminated by proper treatment and, as the spores do not travel a long way, reinfestation is unlikely. Most of the spread of the disease is due to infested seedlings. It has occured to me that the possibility of spread by insects might be worth investigating.

The main effort of the Unit is directed towards research into the coffee berry disease *Colletotrichum coffeanum*, the pathogenic form of a saprophyte, which may cause complete crop loss and is difficult to control. Infestation is from spores on the bark, and if this is sprayed the disease may be controlled, but berry spraying is useless. Mercury is good, but leaves a residue and may also produce Zn-deficiency. Copper fungicides, applied at the correct time give incomplete but economic control, giving a 50-100% yield increase.

The largest single research effort on coffee problems I saw is concentrated at Jacaranda Research Station. When discussing fungal diseases, the Officer in Charge, Mr. P.A. Jones, had some reservations on Dr. Nutman's results that *Hemeleia* dispersal is never wind-born. They hope in future to devote much effort to plant-breeding, as there are some classes of *arabica* resistant to *Hemeleia*. Amongst fungicides, captan looks promising as an eradicant, but copper is still chiefly used as a protectant. In the application field, he and his colleagues depend very much on co-operation with C.P.R.U. and are very enthusiastic about the help received. The importance of finding the best rate of volume has already been mentioned. Copper may cause trouble in the soil, causing iron deficiency, and it is necessary to cut down on the quantity applied. Yet the Indian recommendation of 0.5% Bordeaux had to be increased 4 x 5 times in East Africa to be effective. Mr. J.A.N. Wallis, Agricultural Officer in Charge of investigations and Mr. I.D. Firman, Plant Pathologist, thought that Burgundy mixture would probably be more effective than Bordeaux, but foresaw difficulties in getting this accepted by the growers. Other fungicides being tried include carbamates and thiram.

With coffee berry disease, fundamental investigations are left to Dr. Nutman. They look to him for suggestions when and how to control, and then find out whether it can be done in practice. Here again, hopes are reasonable for an answer through resistant varieties.

A very large number of insect species and their control are studies by the entomologist, Mr. T.J. Crowe. Leaf miners are regarded as most important, with *Antestia* almost equally so. Against the former, diazinon presents the best compromise between effectiveness and safety, but is rather expensive. *Antestia* spraying is recommended, when assay of population gives more than one bug per tree, and phosphorics seem to be most successful. DDT banding, or dusting the base of the stem also gives good results. Routine spraying is not recommended as uneconomical.

As in Lyamungu, much worry is caused by the changes in the biological complex due to indiscriminate use of insecticides, particularly with regard to leaf miners. Much effort is also expended on laboratory work, and I was much impressed by the breeding colonies of *Antestia* and other insects.

Additional insect pests being studied include lepidopterous skeletonisers (of increasing importance), the tip borer *Encosma nereidopa* and white grubs.

In the herbicidal field, couch grass and its control by dalapon has so far attracted most attention, followed by pre-emergence weedkilling on mulch-bands with simazine and CMU.. Mulch is applied chiefly as water-conserver, not as organic manure, and weeds decompose it. Application is by horizontal booms, very low and hooded. High volume and large drop-size are essential to prevent drift.

Dalapon is used both as a general weedkiller and for maintenance spot-spraying. The former use is not so important, but may become so when labour becomes more expensive and less available. For the second use, high skill is essential, and it is necessary to incorporate a marker dye to judge whether the right amount has been put on, and the coffee has not become contaminated. Methylene blue is used, but a better marker is urgently looked for.

An interesting observation, so far unexplained, is that 2, 4-D, which is much used as a general herbicide extends leaf-like on coffee from 8-9 months to up to two years.

Much additional information is still needed on application machinery, which was described to me as the chief bottleneck in the use of general herbicides.

My last contact with coffee research was at Kawanda Agricultural Research Station, Uganda, where Mr. J. Bowden stressed his dissatisfaction with the lack of knowledge on correlation between insect attack and damage caused. This applies particularly to *Antestia*, and he hopes to see more research on proper sampling techniques. He too is hoping for more co-operation and help from Arusha, and sees his own role chiefly in the ecological problems posed by insecticide application.

TSETSE

At C.P.R.U. Arusha, work on this problem is proceeding on three main lines, namely aerial application, discriminative ground spraying and laboratory experiments. It is hoped to add to these shortly research on sterilisation of males by radioactivity.

On aerial application, successes have been achieved against Savannah species (*Glossina morsitans*, *G. swynnertoni*, *G. pallidipes* in Tanganyika, after initial failure against *G. palpalis* (riverine species) in Uganda. The present position is that a block of 11 square miles at Chungai, treated in 1957 with 1/8 gallon of 2.5% dieldrin/acre 8 times, one month apart, at a cost of approx. £1,000 per square mile led to a reduction of over 99%, which has been maintained. In a control block, separated from the treated by a mile of clearing (now partially regenerated) there are still plenty of flies, and it may not be unreasonable to assume that the odd fly found in the treated area is, in fact, an immigrant unable to re-establish the population. Aerial treatment is unlikely to become the standard method for large areas because of its high cost and the high skill required from the pilot. In a comparatively small section like this, the measures for prevention of reinfestation (picketing) are also quite costly. These will presumably have to be maintained until vegetation clearing by the settlers who have moved in makes the area an unsuitable habitat for tsetse. The chief use for aerial application is likely to be for emergency, when speed is all-important. There may also be cases when residual toxicity is undesirable.

I did not see any examples of the discriminative spraying technique, and this aspect is better dealt with in other sections of the report. The principle is, of course, to treat resting places favoured by the fly with a persistent insecticide, so that sooner or later the insect will alight on a treated surface. In this sense, all the successful ground applications described below are discriminative spraying. Mr. Burnett favoured this method for the control of *G. morsitans* in open country with isolated trees and no undergrowth, and suggested the spraying of trunks and branches up to a height of 10 feet.

On the laboratory side, experimental work still relies largely on flies hatched from collected puparia. There, as elsewhere, the large-scale supply of experimental insects from a self-propagating culture seems to present great difficulties owing to the low biotic potential. The purpose of experimental work at present is to find a better insecticide by screening all chemicals they can get hold of. The primary benefit to be derived from a new weapon is a further reduction in cost.

An alternative to insecticidal treatment is discriminative clearing, i.e. the elimination of vegetation foci in which the fly congregates during the dry season, thus making living conditions for it so bad that it will die out sooner or later. Where this is practicable, arboricides would help to reduce or eliminate the recurrent annual cost of maintaining the clearing. Regeneration control costs are estimated as 10-25% of the original clearing cost every year.

At the Kenya Department of Veterinary Services, Kabete, the Zoology Section is concerned with tsetse eradication and subsequent land development. They have been concerned for some time with the eradication of *G. palpalis*, the riverine carrier of human sleeping sickness, in Nyanza province, and their successes make them hopeful of eliminating this scourge from Kenya in due course.

The method is based on the empirically established finding that by treating 1 mile of river, about 6.5 sq. miles are cleared of the fly. A single path is laid down on each side of the river and sprayed by hand four times at 3-weekly intervals with 2% dieldrin at a rate of 3 gallons per mile per application. The all-inclusive cost per mile of river (i.e. 6.5 sq. miles), plus 2 years patrollung with fly boys, is claimed to be as low as £57. Traps are sometimes used instead of fly boys, reducing the cost even further. The comparative cost of bush clearing for a mile of river would be £200-£300. *G. palpalis* lives in a narrow habitat along the river and feeds chiefly on water-visiting animals - crocodiles, lizards, hippo, buck and man. It will therefore rest on the treated paths.

Against wide-spread flies (Savannah species) the method can be adapted by finding out what the focal resting points are, and treating them. They can also be created by laying a grid of paths over the area, as the fly will follow the paths. In the case of *G. pallidipes* it has been found that this species can be attracted by extracts from the hair and skin scrapings obtained from bacon factories applied to a 4 ft. sq. screen for a distance of 400 yds. down wind for about 2 weeks. (This species feeds chiefly on wild hogs). The vegetation around these screen traps is sprayed, and the method is now being tried out. If preliminary results are promising, some chemical research in the U.K. on the attractant might be well worth while.

The grid will consist of paths at 200 yds. interval, crossed by others every 500 yds. During the dry season, these paths will be sprayed at 3 months interval with 5% dieldrin, during the wet season every 4 weeks with 1.8% dieldrin. The latter treatment gives an average deposit of 18 mg./sq.ft. on leaf surfaces, dropping to 9 mg./sq.ft. after 28 days. Kabete is the only place in E. Africa (other than Arusha) at present capable of carrying out such residue analysis, but their facilities are very limited. The cost of this treatment is estimated at £625 per sq. mile, of which the patrols will cost £250. If the attractant method works, costs might be much reduced as the grid can be laid wider. If an insecticide of the same efficiency but larger persistency than dieldrin could be made available, costs would fall very appreciably.

To protect the areas now cleared from *G. palpalis* from reinfestation from Tanganyika and Uganda, it is proposed to lay down a vegetation-free belt of 10 miles along the border, and this raises the problem of suitable arboricides already mentioned. Some of the bush is resistant against existing chemicals and fire. Dibutylphthalate has been suggested as a penetration aid for 2, 4-D, and, in preliminary trials, has killed *Euclea*. Initial clearing would still have to be done by chains (cost: £1000/sq. mile!) but regeneration could be prevented by phytocides.

When the tsetse and the bush have been cleared, about 50% of the land so made available in Kenya could only be used for meat production by ranching, hence the importance of keeping the cost of both operations at a minimum. It may be mentioned here, that the Director of Agriculture, Mr. Swynnerton, has suggested the working out of a cheap chemical bush clearing method, preferably by air, as research target No. 1 for C.P.R.U., Arusha.

It is convenient at this stage to compare the practice of the Uganda Department of Tsetse Control with that of Kenya. In the past, Mr. A.G. Robertson has relied chiefly on hunting, and mainly by this method has reclaimed some 7,000 sq. miles from *G. morsitans* and *G. pallidipes.* The cost for this method is about £96 per sq. mile. Shooting was mostly indiscriminate, but Eland and Giraffe were spared always, and in Ankole (see below) also Impala, Zebra, Leopard and Clipsprinzer. The method relies on fierce late burning to keep the bush down.

Discriminative clearing also was successful. This was employed in the Karamoja district, where distribution of *G. morsitans* was discontinuous. The cost was £160/sq. mile. On the other hand, E.A.T.R.O. failed to arrest the advance of the fly by that method in Ankole.

After this, Mr. Robertson started in July 1958 in this area with 180 hunters, arrested the advance, at least temporarily, but did not eradicate inspite of evacuation of most cattle. He claims that hunting has to be carried on for 4 and sometimes 7 years before success is evident. Use has to be made of the "long-term cycle" of the fly, which lasts 11 years and has been unfavourable since 1955. It ought to be said that he is as keen as anyone to abandon the wholesale destruction of game.

In his insecticidal work, he has worked jointly with C.P.R.U. In 1955 the Osia river valley near Tororo was successfully cleared of *G. palpalis* by 3 applications of 6% DDT in intervals of 3 weeks, using otherwise much the same methods as the Kenya workers. Later on, successes were achieved with 2 applications of 2.1% dieldrin with an interval of 4 weeks. The cost amounted to £25/mile, presumably not including 12 months patrolling.

Finally, Mr. Robertson switched to a single application of 6% dieldrin. He has cleared 300 miles of river in the North Lango area, and 60 miles of the West Nile of *G. palpalis* by this method at a cost of about £16/mile, though isolated areas had to be resprayed. As a result, he regards the eradication of *Trypanosoma gambiense* from Uganda as completely practicable, if not already accomplished.

When asked why the Kenya people should find it necessary to consolidate their clearing of *G. palpalis* by a 10 mile treeless barrier on the Uganda border, he replied that eradication on the Uganda side was not practicable owing to high cost neccessitated by the topography of the lake shore and the type of bush, and thought that Kenya would probably be re-invaded in spite of the barrier from canoes, etc.

Against *G. morsitans* an experiment was undertaken with C.P.R.U. in an ecological island in the Kapiganda valley where 17 square miles were treated by discriminative spraying of trees up to 12 feet, about 6.75 trees/acre, working from the middle of the area outwards. 3% dieldrin was used, and *G. morsitans* was nearly eradicated, but some re-infestation took place, as progress was so slow (labour shortage) that the insecticide had disappeared from some part of the area before the whole could be treated. It was found that 90% of the dieldrin had disappeared in 4 months, all in 8 months. A smaller experiment was completely successful.

This encourages the department to tackle the Ankole problem, where the fly is still threatening further advances, by insecticidal methods. A grid of ground spraying is to be laid throughout the infected territory, 11.3 trees/acre are to be sprayed with 5 ozs. of "Dieldrex" per tree. The cost is estimated to be about £160/sq. mile which seems very reasonable indeed for the eradication of a Savannah species. It is hoped to make a chemist from the Pool of Colonial Pesticide Chemists available for this work.

Dr. P. Glover of Kabete, whom I met later on in Nigeria, has commented to me about the differences in the Kenya and Uganda methods for the control of *G. palpalis*. The object is not the same. Kenya has a limited problem only and aims at total eradication. They can therefore not afford to run risks and 3 applications are essential for the last emerging fly to be destroyed. Uganda, on the other hand, has vast areas infested, surveys are much more difficult, and they must be content to break the transmission cycle. One application of 6% dieldrin may reduce the population by 99.9%, but the fly will come back slowly. In the meantime, medication will have disposed of the disease, there is no reservoir of wild animals and the cycle will have been broken.

The game destruction methods of the Tsetse Department naturally came under sharp criticism when I visited the Game Fisheries Department in Entebbe. Captain Newton claimed that the areas so cleared are completely bare, there are no huts, no people and no cattle. The grazers just have not moved in, and population there is insufficient to provide an incentive for them to do so. Furthermore, game feeds on all vegetation, thereby helping to keep the bush down, while cattle only grazes. Finally, tsetse is the one sure way to prevent overgrazing, as people who do not follow the Veterinary Department's advice get no drugs for their infected cattle. Discriminative clearing and insecticides were, however, not objected to.

These criticisms were regarded as wildly exaggerated by Mr. R.N. Sanders, Director of the Veterinary Department, who claimed that people and cattle were actually moving into the cleared areas, though some local superstitions had to be overcome first. Resettlement has, of course, to go hand in hand with a sound livestock policy.

Mr. Sanders was very interested in the Ankole plan, in which his department co-operates. He has the idea of treating some cattle with dieldrin and use them as bait in the area. The animals will be sacrificed, but should yield information on the dieldrin residues in body tissues, with the help of the chemist to be supplied. A tentative experimental plan was discussed between us.

The possibility of trypanosomiasis being transmitted "mechanically" by other insects than Tsetse, in particular by *Stomoxys* appears to be a very real one. Both Mr. Sanders and Mr. H. Parr (C.P.R.U. Entebbe) thought there was quite a lot of field evidence for this, though it had so far been found impossible to prove it in the laboratory. The organism suspected of being so transmitted is *T. congolense*.

An entirely different research approach from anything else seen in Africa rules at E.A.T.R.O. at Tororo. Dr. Lumsden and his colleagues deliberately leave all insecticide and reclamation work to others and concentrate on the fundamental aspects of Tsetse biology, epidemiology, immunology and biochemistry. Most of their work is concerned with Trypanosomiasis rather than with Tsetse and would not be appropriate for inclusion in this report, so I cannot deal with the majority of the highly stimulating conversations I had in Tororo.

Dr. Lumsden, commenting on the work of the Kenya and Uganda territorial organisations (described above) pointed out that *G. palpalis* is much easier to eradicate in Kenya than in Uganda. In the latter country, particularly on the lake shore, vegetation is much thicker and less accessible. The fly extends up to 10 miles inland.

He doubted whether it was an economic proposition to control "wide-spread" fly by insecticides. Drugs are much more promising for disease eradication, and drug resistance is not yet more than a local problem and can be largely avoided by proper use.

If disease is to be eradicated by killing tsetse, nothing short of complete eradication will suffice (a point also made by others). In West Uganda, the density of *G. morsitans* is very low but has proved no barrier to disease transmission.

At E.A.T.R.O., he wishes to study the epidemiology of Trypanosomiasis in an area heavily infected with *T. rhodiense*. Information about the carrier is as yet insufficient, and potentially all Tsetse must be regarded as carriers. He ventured a "hunch" that *G. palpalis* was the carrier in normal times, while during epidemics *G. pallidipes* also transmitted the disease.

In Eastern Uganda both Tsetse and *T. rhodiense* occur but on the Western lake shore and in West Tanganyika there are plenty of Tsetse but no sleeping sickness, in spite of much population movement. Could the answer be in the different habits of the humans? In the infected areas, people are fishermen, approaching the tsetse areas from the lake, while in the free areas they are cultivators.

Like others, he also agreed that research was needed on "inter-herd" mechanical transmission by biting flies, such as *Stomoxys* and tabanids. Dr. J.P. Glasgow, the Chief Entomologist, studies the correlation between fly size, fat content, etc. to seasons, evaporation rates and other ecological factors. He maintains a flourishing culture of tsetse which, however, is not self-propogating but relies on catches of wild females. The captive adults are fed either on goats or on defibrinated blood through an artificial membrane.

Dr. Glasgow considers eradication of the fly without changing the habitat dangerous and unsafe, and is therefore opposed to the insecticidal approach. He quoted the case of Principe Island on the West Coast of Africa, where Tsetse had been cleared in 1912-15 by putting "something sticky" on the back of men, to catch the flies. Now they are back again, or had never been extinct.

The failure of discriminative clearing by E.A.T.R.O. in Ankole was explained by him and his colleague, Mr. Harley, as due to insufficient speed. The fly dropped 77% in the first year, then down to 99% in 3½ years, but eventually simply got ahead of the clearing and built up again. They thought, however, that though a much greater effort would be needed to make the method a success, it would still be cheaper and in the long run more effective than insecticides.

A somewhat similar function is filled in West Africa by W.A.I.T.R., though their outlook is a little more towards the applied side than E.A.T.R.O. I saw the laboratories at Kaduna, where work on human trypanosomiasis and entomology is concentrated, the veterinary and protozoological work being catered for at Vom. Mr. T. Leach the Deputy Director and his colleagues told me that their chief work on tsetse was concerned with the ecology of the most important species, viz. *G. morsitans* and *G. tachinoides* for animal, and *G. palpalis* and *G. tachinoides* for human disease. The last-named is most important in the Sudan Savannah, where there are open woodlands, and where it occurs in the same habitat as *G. morsitans* during the wet season.

They are badly understaffed on the entomological side, but hope to make a major effort in the insecticidal field. For this purpose they hope to obtain the services of an entomologist and a chemist from C.D. & W. funds; to overcome the legal difficulties posed by Nigerian independence, Mr. Leach suggested that these should be appointed to Arusha and seconded to W.A.I.T.R. In the meantime, a certain amount of insecticidal work is done in the laboratory.

Two species are being bred, *G. palpalis* which yields a small surplus for experimental purposes, and *G. morsitans*, still depending on support from wild catches. The laboratory breeding of any species of tsetse, here or elsewhere, is certainly still very far from giving a practical lead towards mass production of males for sterilisation.

Practical control measures and reclamation schemes in Nigeria are strictly divided between the two Ministries concerned according to whether the purpose is eradication of human or animal disease, and the methods used by the two departments differ slightly. Dr. W.W. Kirkby, Principle Veterinary Officer in Tsetse Unit discussed with me some of the schemes to eradicate Savannah species by insecticides for the protection of cattle.

Their first trial was at Bulkachuna, where an isolated block of 7 square miles, infested with *G. morsitans* and G. *tachinoides* was treated in the dry season of 1956 by discriminative spraying. DDT w.p. (presumably 50% a.p.) was sprayed at 1 lb./gallon on tree trunks up to 6 feet. There were two applications one month apart, but in some parts only one application was used. Both treatments gave eradication in one year.

In 1957, they went further north, where the fly congregates in river valleys during the dry season. 1 lb./gallon DDT w.p. was again used, but this dosage was later cut to ½ lb./gallon, bio-assay tests having established that even ½ lb/gallon still gave a toxic deposit for at least 53 days. They advanced progressively up the river valley eradicating the fly with a width of 4-5 miles for the zone of treatment. There was no re-invasion of the cleared zone beyond 1 mile in spite of the lack of any barrier. Every tree as thick as a man's thigh was sprayed to nearly run-off by knapsack sprayers up to height of 4 feet. The cost of the operation worked out from £96-£128 per square mile. Eradication was vital, as the game was left undisturbed, and even a small number of survivors could have maintained the transmission cycle.

Dr. Kirkby reported that the fly disappeared immediately when spraying started, and wondered whether there was a repellent effect. He stressed the importance of having a visible deposit, which is a strong argument in favour of wettable powders rather than emulsions.

Dr. Wilson, from the Northern Region Ministry of Animal Health and Forestry, went on record with the opinion that discriminative spraying gave the only possible approach to tsetse clearing in the type of country in which he is interested, and stressed that much more must be done to work out the best and most economical methods for the Guinea Savannah. As the country is fairly open, with no thickets etc., he foresaw no particular technical difficulties, but there is no long dry season.

The control of human trypanosomiasis in Northern Nigeria is the concern of the Sleeping Sickness Service under Mr. P.J. Kernaghan, part of the Ministry of Health. They have been working chiefly in the wide woodland riverine valleys of the Sudan Savannah, particularly in the Dudderun Gaya valley. This is a floodplain of up to 3 mile in width, with woodland with thickets, which provide rooting grounds for warthog. As conditions become drier, the fly congregates nearer and nearer to the river. All vegetation is sprayed to about 500 feet on either side of the river, (but up to 1 mile in parts, where there are subsidiary water courses) up to a height of 4 feet, especially bushes and low leaves, but big trees are not touched. This applies to *G. tachinoides; G. morsitans* in the same habitat poses a more complicated problem, as it congregates elsewhere than on the river, though in discreet units. Where it occurs, every thicket, such as tamarisk trees on termite hills, has to be covered.

While the veterinary practice is to cut a path through the thicket to the main tree and spray that, the Sleeping Sickness Service just sprays all around the thicket and as far in as possible. This is more expensive in chemical, but cheaper in labour. Both methods seem to be equally effective. Costs were not quoted, but cannot be very different from those for the veterinary method.

50 square miles were cleared in the Dudderun Gaya scheme and a total of 12 tons of pp-DDT in the form of wettable powder was used. The application rate was a little higher than in the veterinary practice.

To sum up my impressions on the progress of tsetse reclamation in Africa, it seemed to me that the vast majority of the workers I interviewed were convinced that the future was with the insecticidal approach. In spite of the dangers seen by Dr. Glasgow, I cannot see any really practicable alternative. High costs and shortage of skilled personnel are likely to make progress painfully slow, but in view of the frightening amount of overgrazing and subsequent erosion I have seen, that may not necessarily be a bad thing, at least where the carriers of animal trypanosomiasis are concerned. Tsetse eradication may cause more harm than good unless it goes hand in hand with an enlightened policy on stock control and anti-erosion measures.

MALARIA

Control and eradication schemes

All attempts to eradicate malaria from areas of any size in Africa at present contain an element of research, and must be regarded, in a way, as pilot schemes rather than the routine application of methods proved successful elsewhere.

In Tanganyika, I was informed by Dr. Lister, D.M.S., there are at present no attempts to control rural malaria by residual spraying, as this is beyong the financial means of the country. Larviciding, mostly in urban areas, is the only means employed at present. In the past, three attempts had been made to eradicate the disease by residual spraying. One is the Taveta-Pare Scheme, to be dealt with below, the second an isolated settlement in the middle of the tsetse belt, Mpanda, where the disease was much reduced but transmission not fully interrupted, and the third at Mtawara, isolated on the coast, where the attempt has now been abandoned and larviciding resumed. In all these, *Anopheles gambiae* is regarded as the most important vector.

The Taveta-Pare Scheme (of which I visited the Taveta part in the company of Dr. A. Smith of C.P.R.U., and on which I had much conversation with other C.P.R.U. members and with Dr. Lister) was sponsored five years ago by the E.A. Malaria Institute, and the territorial Governments, the E.A. High Commission, C.D. & W., W.H.O. and C.P.R.U. all co-operated in varying ways and degrees in its execution. All houses were sprayed six times at intervals of about 9 months during the active phase of the scheme. As new houses are being built all the time, this means that probably about 90% of the houses now occupied had treatment. At the 1st spraying, 80 mg./sq. ft. dieldrin was laid down, subsequently half that dosage was employed. The last treatment was in February 1959, but at the time of my visit, some 15 months afterwards, kills of 80-100% were still obtained from walls, in 3 hours exposure, of *A. gambiae*, and 50-90% from the roofs.

Since spraying operations closed (largely for financial reasons) C.P.R.U. has been responsible for the surveillance of the Taveta area, and assesses the return of the vectors. *A. funestus* appears to have been eradicated, but *A. gambiae*, which at one time had been reduced to 20% of its original strength, is now rapidly building up to its old numbers again, with some indication of heavier infestation in untreated huts than in treated. C.P.R.U. uses both spray catches and strategically situated box shelters for its survey, and maintains an Assistant Field Officer (Mr. Kitambe) and 3 mosquito orderlies at Taveta. They study forest and plain areas, the effect of bush clearing, etc., and follow the life of the toxic deposits by bio-assay. It is planned to do a series of observations on whether the treated huts still kill wild mosquitoes entering and leaving freely, as opposed to the laboratory-bred used in confined bio-assay tests. Results in Magugu have indicated the possibility that bio-assay tests do not always give an indication of the fate of the wild population.

At the same time, a surveillance of blood samples is carried out on people complaining of fever, and these are given anti-malarial drugs.

Research is also carried out on the habits of *A. gambiae*, which are as yet far from clear. I understood Dr. Lister to be of the opinion that the main reason for the failure to eradicate *A. gambiae* had been that this insect does not always enter houses. On the other hand, Mr. Burnett told me that in those areas where cattle and man live under one roof, it does not rest outside.

The results of the Taveta-Pare Scheme to date may be summarised as follows.

(1) Clinical malaria has almost disappeared.

(2) There is still a fair amount of the parasite found in human blood.

(3) The population density of *A. gambiae* has only temporarily been reduced.

When both vector and disease are still extant, it is impossible to speak of eradication, in spite of success as control. From the research point of view, however, the scheme has proved extremely fruitful and continues to be so.

In Zanzibar, a W.H.O. Team consisting of Dr. Stoker (malariologist) and Dr. Iyengar (Entomologist) with assistants has been active since June 1957. At present they describe their work as control, but are hoping to proceed to eradication eventually. Spraying started in April 1958, and a year later, at the time of my visit, they had just started on the third spraying cycle. This covers every house in the two islands, with the exception of the "stone town" where there are no mosquitoes. The important vectors ar *A. gambiae* and *A. funestus*.

The material used throughout is dieldrin, to give a wall deposit of approx. 0.6 g./m^2. The original intention was to spray once a year, but dieldrin has proved insufficiently persistent. This year *A. gambiae* was early (March) and the deposits laid down in the spring of 1959 had lost their toxicity. Finances permitting, the intention is now to spray every 6 months. Attempts to use a dieldrin-resin formulation in the hope of achieving greater persistency had to be abandoned as it blocked up the stirrup-pump nozzles.

Before operations started (October 1957) a survey of children up to 9 years disclosed a spleen rate of about 70% in Zanzibar, and even more in Pemba. By October 1959 this had fallen to 35% in Zanzibar, with a parasite rate of 30%. Dr. Stoker thought that the local people kept parasites in their body longer than elsewhere. Apparently about 1 year without drugs is normal for *Plasmodium falcipara* and 2-3 years for *P.vivax.* If these estimates have to be revised upwards in Zanzibar, a longer period of spraying will be necessary to break the cycle. At present, parasite studies are mostly done on infants up to one year old, as these cannot carry over the parasite. Before treatment commenced, the infection rate was 40%, now it has dropped to 0.5% among babies who had never been away from the island. It is higher among those who had visited the mainland or been born there.

Every immigrant into the island is supposed to receive a single dose of 600 mg. Divaprine/Chloroquinone, but so many people enter uncontrolled (from fishing boats etc.) that there is much likelihood of continued importation of the parasite.

Dr. Iyengar is making a study of the habits of *A. gambiae*, particularly on the place of feeding. After two spray applications, they had hopes that the insect had gone, but it reappeared when the rains came early before the third spraying. If it feeds outside houses on man, then the chances of eradication are remote. He is wondering whether it might be possible to spray cattle as a bait for those insects never entering houses.

In Pemba, a race or variety of *A. gambiae* breeds in brackish water, and the question arises whether this also is a malaria vector. So far, there is no positive result for this, and Dr. Iyengar hopes to try artificial infection in the laboratory, but has great difficulties in getting a pure culture of the strain going.

There are no control or eradication schemes by means of insecticides going on in Kenya at present. Dr. G.A. Walker, D.M.S., told me that these were considered too expensive, and that Dr. Heisch, who is in charge of malaria control, is hoping to break the cycle by medication only, following mathematical theory of epidemics. The results look promising. Devachlor is the chief pharmaceutical weapon, and a pilot scheme is in progress in Shimba Hills, a reasonably isolated area of 15-20 sq. miles. Random catches of *A. gambiae* and *A. funestus* are made to ascertain the sporozoite rate.

In Uganda, active control is confined to larviciding and draining in urban areas, according to Mr. G. Barnley and Mr. M.A. Prentice of the Entomology Division, Medical Department, Kampala. Medication is the only weapon in the case of rural malaria at present. There is considerably controversy about the Uganda Government's active encouragement of the establishment of fish ponds to raise the nutritional standard of the population. These provide ideal breeding grounds for *A. gambiae* and A. *funestus* and, in the Division's view, do more harm than good. As there is little or no fertilisation of the ponds, the gain in fish is small, and malaria is much increased, while there is also danger of bilharziasis being carried in them. Conditions are created for breeding of Anophelines in country otherwise unable to support them. (Needless to add, these views were sharply contested by the Fisheries Department which I visited them later on.)

Mr. Barnley was doubtful whether there was much point in making a major effort against *A. gambiae* in the rural areas of Uganda at present. Mosquito populations are going up as more fish ponds and water dams are being created, and there is indication, though no proof, that malaria is also going up. He quoted the case of a certain pastoral nomadic tribe which had been reported as becoming "more idle" and was wondering whether this might not be due to an increase in malaria. The Government was now much concerned with water conservation, irrigation, etc. in the interest of better agriculture. The first need of the moment was to establish how all these factors affected the malaria problem rather than to commit the very limited resources to eradication schemes which might be impracticable and applied in the wrong place.

I was unable to visit the Kigesi area in S.W. Uganda, where W.H.O. and the Uganda Government are running a joint eradication campaign, but here are Mr. Barnley's comments on it. The scheme, which is in charge of Dr. de Zulueta of W.H.O., started two years ago with the object of eradicating malaria in an over-populated area with resettlement of non-immune persons in new lands. The territory is comparatively high above sea level, and the original survey had indicated that *A. gambiae* did not breed above 4,500 ft. This estimate was subsequently shown to be too optimistic, and the residual spraying and medical prophylaxis measures undertaken had to be on a larger scale than originally envisaged. *A. gambiae* is now much reduced, but not eradicated, and it looks like spraying having to be maintained for a long time to come yet. The scope has spread further and further from the originally envisaged resettlement scheme.

If anywhere in Africa, Kigesi should afford an opportunity to eradicate *A. gambiae* as it breeds only in man-made conditions in the higher parts of the country, which account for most of the area. There is a possibility that the transmission cycle has actually been broken, but there is divergence of opinion on that. Dr. de Zulueta is now breaking into the Masaka district, where conditions are much more difficult, partly through lack of co-operation by the population.

Dr. H.M. Archibold, of the N. Nigerian Ministry of Health, who is malariologist in charge of the Western Sokoto Scheme in the Sudan Savannah, gave an outline of the history and present outlook of that experiment. It started in 1953 in an area of 600 sq. miles with 124,000 inhabitants. It had been planned to double it in the 3rd year, double again in the 4th, and so on, but actual expansion stopped when an area of 500,000 people was covered, and there is no very great immediate likelihood of further expansion. W.H.O. had provided originally two entomologists (now only one, Dr. Ramakrishna) a Sanitarian and a laboratory technician, U.N.I.C.E.F. transport and stores, and the Northern Region the services of Dr. Archibold and all other expenses.

After some pilot experiments and surveys, every hut in the original area was sprayed with wettable powder twice a year in 1954. In the Northern part of the scheme, the insecticide used was dieldrin at 25 mg./sq. ft., in the middle DDT at 200 mg./sq. ft. and in the South γ-BHC at 25-40 mg./sq. ft. In the middle of 1955 it was found that dieldrin was no longer effective, as *A. gambiae* had developed resistance. Since September 1956, DDT has been the only weapon employed,; it is now 3 years since the scheme has been fully functional on that basis, but the early hopes to interrupt transmission in that time have not been fulfilled.

One of the reasons may be that DDT does not persist for the full 6 months between sprayings on the substrate of dried mud and thatch. Langbridge from C.P.R.U., who visited the area in 1955-56 found good chemical persistence, but the biological data do not agree. It is possible that the insecticide deposit is made ineffective by smokes from domestic fires, etc. Regular bio-assay is difficult for lack of staff and other reasons.

It is hoped to try the effect of 3 sprayings with DDT every year, but the cost would be rather high. For the present 2 sprayings 2/6d. per head of population per year is being expended, which is more than the medical budget for all purposes in N. Nigeria.

Transmission has never been interrupted, and persistent parasitaemia still exists everywhere. Nevertheless, malaria has been much reduced, particularly in infants under 5 years, and as a control measure, the results of the scheme are satisfactory to the region, and it may be continued on the present basis of 500,000 people. It has also led to the incidental reduction of termites, nuisance biting, etc.

Dr. Archibold thought that N. Nigeria had no hope of proceeding to an eradication scheme, even if the knowledge of how to do it was available. Eradication of *A. gambiae* is unlikely to be achieved by house-spraying as outdoor resting and biting does occur, though there was the hope of eradicating malaria by breaking the transmission cycle. If the majority of adult insects do invade houses, this possibility exists. The indications in W. Sokoto are that this is indeed the case, but the habits of the insect vary considerably from place to place in this respect. In Kaduna, for instance, many more stay out of doors than in Western Sokoto.

A pilot scheme involving 30,000 people has been tried towards malaria eradication by chemotherapy. But unless mosquito control is so effective that transmission is virtually interrupted, the results of curative chemotherapy are only ephemeral.

As for chemoprophylaxis, monthly medication with Divaprine has been tried in a village area, but the parasite became resistant to the drug. Daily prophylactic treatment is not considered practicable, but weekly dosing may be possible.

In the urban areas of the scheme, larviciding is in progress but has so far led only to an abatement of the problem. A complicating factor throughout the area is the movement of the vector in the temporary shelters of the migrant pastoral people.

The problems of the forest zone in the coastal belt are quite different from those of the Savannah. Dr. Spitz, regional representative of W.H.O. in Lagos, informed me that transmission had been successfully interrupted in the Yaunde region of the Cameroons Republic, and that the position is very hopeful in other places. Plans are now being made for a continuous joining-up of all the forest zone schemes along the coastal belt of West Africa, and schemes are at present in operation in Liberia, Ghana, Dahomey and elsewhere.

It is important to remember that the chief vector in these areas is *A. moucheti*, and that *A. gambiae* is comparatively unimportant. Another reason for the greater success is that people sleep more indoors in these zones. Outdoor sleeping is common only in hot and dry weather, and this is the season when there is least biting. Dr. Spitz stressed that an insecticide of greater persistence, particularly on thatch, would be a great help throughout Africa.

The last scheme with which I came in contact was Mr. R. Elliott's work on Victoria Island, Lagos. Mr. Elliott described the major object of the scheme of convincing the Lagos Town Council of the merits of residual spraying in semi-rural areas where larvicidal operations are not very practicable. The vectors involved were *A. gambiae* and *A. gambiae var. melas*. The latter is a salt-water breeding variety, which had previously been controlled mainly by the building of sea-walls to deprive it of suitable breeding grounds. Draining had also been practised.

Mr. Elliott used a mixture of DDT and γ-BHC, at a dosage of 1.5 gm./sq. m. for the former and 0.15 gm./sq. m. for the latter, applied as wettable powder in March and again in September 1959. The Lagos Town Council is now continuing with DDT alone, but Mr. Elliott considers this disappointing, as he thinks the mixture is the key to effectiveness. As far as possible, every house has been sprayed, but the villages are growing so fast that many people must have slept in unsprayed houses.

Parasite rates were studied before and after operations, and so far the only really significant and worthwhile reductions have been achieved in infants up to 10 years.

I have not attempted to remark on the laboratory and hut experiments at C.P.R.U. Arusha in this report. This work would be rather incongruous to the rest of this section, and I felt that readers are adequately informed on it by the regular reports and papers received. The work of the W.H.O. Insecticide Testing Unit at Lagos seemed likewise unsuitable for inclusion, as their problems at the time of my visit were almost entirely organisational contingent on the early stages of their existence, and therefore only of transient interest.

Looking back on this tour one cannot help feeling somewhat depressed at the enormity of the problem posed by the control and eradication of malaria in tropical Africa. Quite apart from financial and organisational difficulties, there is as yet no clear indication that we have the technical knowledge to break the transmission cycle and eradicate malaria by insecticides where *A. gambiae* is the main vector. The behaviour of this insect seems to be insufficiently understood and may vary from habitat to habitat. Measures on how to deal with it where outdoor feeding and resting is important have yet to be devised. The only claim, as yet not substantiated with certainty, to have interrupted transmission by *A. gambiae* amongst the schemes reported on, comes from the high-altitude region of Kigesi in Uganda, with rather atypical condition.

Control (as opposed to eradication) of malaria certainly has met with a large measure of success, but this falls far short of what has been achieved in other parts of the world, and will constitute a continuous call on money and manpower. It also involves the danger pointed out by Dr. Bagster-Wilson of reducing the immunity of the population of the endemic areas. I certainly could not help regretting that the large research effort on finding new insecticides is not matched by an equally intensive enquiry into the fundamental problems of behaviour and biology of the vector.

ITINERARY

7.5.	Arrived Dar-es-Salaam	
8.5.	Dar-es-Salaam, Ministry of Natural Resources.	Mr. A.E. Trotman, Minister. Mr. M. Lunan, (Deputy D. of A.) Mr. A. Forbes (D. of A.) Mr. D. Jones (Acting Chief Resl. Officer)
9.5.	Dar-es-Salaam, Veterinary Dept.	Mr. D. Jones (Mr. J.E. Roe (D.V.S.) (Mr. R. Arnold (Chief Res. Officer,V.S.)
	Forestry Dept.	(Mr. C.S. Cree (Dep. Chief, Forestry Dept.) (Mr. D. Groom (Chief Conservation Dept.)
	Ministry of Health	Dr. J.M. Lister (D.M.S.) Dr. W.J.M. Evans
10.5	Chambezi Coast Agricultural Station.	Dr. D.G. Turner, (Botanist) Mr. Minto, (F.O.) Mr. Spens (District A.O.)
	Bagamoya.	General visit to see cultivations, etc.

11.5	Zanzibar, Dept. of Agriculture.	Mr. A.K. Briant (Dir. of Ag.) Mr. R.K. Tremlett (Ass. D. of A.) Mr. B. Hyde-Wyatt (C.P.R.U.)
	W.H.O. Malaria Team	Dr. Stoker (Malariologist) Dr. Iyengar (Entomologist) Mr. Shute (Tech.) Mr. Showman (Tech.)
12.5	Travelled to Arusha by air.	Mr. K.S. Hocking.
13.5	C.P.R.U., Arusha	Mr. K.S. Hocking Mr. G.F. Burnett
14.5	C.P.R.U., Arusha	Mr. K.S. McKinley Mr. S.D. Hocombe 5 delegates from C.O.P.R.A.S.
15.5.	C.P.R.U., Arusha	Mr. K.S. Hocking
16.5.	C.P.R.U., Arusha	Mr. S.D. Hocombe
	Tanganyika Planting Co. Ltd., Arusha Chini.	Mr. L.B.B. Bjorking (Agronomist)
	Lyamungu Coffee Research Station.	Mr. R.G. Tapley (Entomologist) and assistants.
17.5.	C.P.R.U., Arusha.	Mr. J.A. Armstrong Mr. G.F. Poulton Mr. R.E. Rapley Major G.C. Dauber and assistants.
18.5.	Chungai.	Mr. G.F. Burnett
19.5.	Chungai, Masai Steppe, Magugu.	Mr. G.F. Burnett
20.5.	Magugu.	Mr. K.S. Hocking Dr. A. Smith
21.5.	C.P.R.U.(, Arusha	Mr. Paddock) Fisons Pest Control Mr. Miller)
		Mr. A.W.D. Miller
23.5.	C.P.R.U., Arusha.	Mr. E.T. Mesmer Mr. C. McKone Mr. E.N. Shikony
24.5.	C.P.R.U., Arusha.	Mr. C.W. Lee Mr. I. Lusasi
	Northern Regional Research Centre, Tengeru.	Mr. B.G. Houston (Plant Breeder) Dr. G.D. Anderson (Chemist) Mr. D. Richards (Machinery)

25.5.	Taveta Malaria Eradication Scheme.	Mr. K.S. Hocking Dr. A. Smith Mr. N. Crossland Mr. P. Kitambe and assistants.
26.5.	To Nairobi by road.	Mr. & Mrs. K.S. Hocking
27.5.	Nairobi, Ministry of Agriculture.	Mr. R.J.M. Swynnerton (D. of A.) Mr. L.H. Brown (Chief Agric.) Mr. A.R. Melville (Chief Res. Off.)
	Nairobi, E.A. High Commission.	Lt. Col. Fearon
	Nairobi, Scott Laboratories.	Mr. E. Hainsworth (Plant Pathologist) Mr. D.G. McCrae (Ent.) Mr. R. Kemptin (Chemist)
	Coffee Berry Disease Unit	Dr. F.J. Nutman (Plant Path.) Dr. F.M. Roberts (Plant Path.)
28.5.	Muguga, Kikuyu, E.A.A.F.R.O.	Dr. E.W. Russell (Director) and others
30.5.	Ruiru, Jacaranda Coffee Research Station.	Mr. P.A. Jones (I/C) Mr. T.J. Crowe (Ent.) Mr. J.A.N. Wallis (Agri. Off.) Mr. I.D. Firman (Plant Path.)
	Nairobi, Ministry of Health	Dr. G.A. Walker, (D.M.S.) Mr. Harvey (Tech.)
31.5.	Muguga, Kikuyu, E.A.V.R.O.	Mr. H.R. Binns (Director)
	Nairobi, Desert Locust Survey.	Mr. P.R. Stephenson (Director)
1.6.	Kabete, Veterinary Research Laboratory.	Mr. K.D.S. MacOwan (Director) Mr. E.F. Whiteside (Zool. Dept.) Mr. E.C. Trump " " Mr. W.P. Langridge " " Dr. P.E. Glover (later on in Kaduna)
2.6.	Molo, Pyrethrum Research Station.	Dr. P.W.U. Kroll (Off. I/C,Pyrethrum) Mr. J. Bullock (Ent.)
3.6. - 10.6.	On leave at Sigor, West Suk (Opportunity for study of local agriculture & health problems.)	
11.6.	Kitale, Grassland Research Station.	Dr. E.D. Bumpus (I/C) Mr. A.V. Bogdan

13.6.	Tororo, E.A.T.R.O.	Dr. W.H.R. Lumsden (Director) Dr. J.P. Glasgow (Ent.) Mr. J.M.B. Harley (Ent.) Dr. R.H. Knight (Biochemist) Dr. D.H.H. Robertson (Veter. S.) Dr. M.P. Cunningham (Veter. S.)
	Jinja, E.A. Fisheries Research Organisation.	Mr. D.G. Garrard.
14.6.	Namulonge, E.C.G.C. Cotton Research Station.	Mr. L.C. Hughes (I/C Plant breeder) Dr. R. Robinson (Ent.) and others.
	Kawanda, Agricultural Research Station.	Mr. J. Bowden (Ent.)
15.6.	Kampala, Medical Dept., Entomology Division	Mr. G. Barnley Mr. M.A. Prentice
	Kampala, Makerere College.	Mr. Vowles (Registrar) and several biologists on the academic staff.
	Kampala, Uganda Forestry Dept.	Mr. K.W. Brown (Ent.) Mr. C.H. Took (Engineer)
16.6.	Entebbe, C.P.R.U. Biting Fly Unit. Visit to Koja Peninsula experiments.	Mr. H. Parr Mr. J. Grose.
17.6.	Kampala, Dept. of Tsetse Control.	Mr. A.G. Robertson
18.6.	Entebbe, Game & Fisheries Dept.	Mr. R.F. Newton (Dep. Dir.) Mr. D. Rhodes (Fishery Officer)
	Kajansi Fish Farm.	Mr. C.J.H. Simpson
	Kampala, Dept. of Veterinary Services	Mr. R.N. Sanders (D.V.S.)
20.6.	Entebbe, Ministry of Health.	Dr. C.W. Davies (D.M.S.) Dr. B. Hopwood
	Entebbe, Ministry of Natural Resources.	Mr. Killick (Minister) Mr. Williams (D. of A.) Mr. Webster (Cons. of Forests) Mr. Rwetsiba (Parl. Sec.)
20.6.	Entebbe, Animal Health Research Centre.	Dr. D. Rollinson (I/C) Mr. R.M. Bredon (Chemist) Mr. H. Parr (C.P.R.U.) Mr. J. Grose (C.P.R.U.)
21.6.	Entebbe, E.A. Virus Research Organisation.	Dr. A.J. Haddow (Director) Dr. J.D. Gillett (Ent.)
22.6.- 23.6.	In transit to Nigeria via Leopoldville-Brazzaville (By air)	

24.6.	Kano, W.A.S.P.R.U.	Mr. M. George (I/C Engineer) Mr. P.S. Previtt (Ent.)
25.6.	Kaduna, Northern Region Ministry of Health.	Mr. R.J. Kernaghan (Ent.) Mr. J.B. Davies (Ent.)
	Kaduna, W.A.I.T.R.	Mr. T.W. Leach (Dep. Dir.) Mr. L.C. Cronje (Vet. Surg.) Dr. P.E. Glover (Kabete) Mr. Southern (E.A.T.R.O.)
	Kaduna, Veterinary Dept.	Mr. W.W. Kirkby (Vet. Surg.)
26.6.	Kaduna, Min. of Health.	Dr. H.M. Archibold (Sen. Malariologist)
	Katabu, Sleeping Sickness Service	Mr. R.J. Kernaghan (Ent.) Mr. J.B. Davies (Ent.)
27.6.	Kaduna, W.A.I.T.R.	Mr. T.W. Leach (Dep. Dir.) Mr. Bello, (Lab. Tech.)
	Min. of Animal Health & Forestry.	Dr. H. Wilson (Tsetse Control Officer)
28.6.	Lagos, Ministry of Health.	Alhaji Ibrahim Waziri, Minister. Dr. Simpson (Perm. Sec.) Dr. M.A. Fawkes, (P.M.O.) Mr. R. Elliott (Fed. Mal. Ser. Ent.) Dr. H. Spitz (W.H.O. Reg. Rep.)
	Yaba, W.H.O. Insecticide Testing Unit.	Dri.M. Rao (Ent.) Dr. J.M. Press (Chemist) Mr. P. Caprari (Tec.) Mr. P. Regamy (Tec.) Mr. T.F. Ogunwamoja (Sanitarian) Mr. R. Elliott (F.M.S.)
29.6.	Lagos, inspection drive through I.T.U. villages.	I.T.U. Team Mr. R. Elliott
	Federal Malaria Service	Mr. R. Elliott
30.6.	Lagos, W.A.S.P.R.U.	Mr. J. Riley (Ent.)
	Visited by	Mr. P.O. Park (Chemist, C.P.R.U., Seconded to W.A.C.R.I.)
30.6.1.7.	To Rome by air.	
1.7.	Rome. F.A.O., Plant Production & Protection Division.	Dr. J. Knoll (Director) Dr. Lee Ling (Chief, Crop Prot.) Dr. H. Walker (Ent.) Mr. O.B. Lean (Locusts) Dr. T.Dobrovsky (Stor. Prod.) Dr. R. Egli (Plant. Path.) Mr. S.H. Phillips (Admis.) and others.
2.7.	To London by air.	

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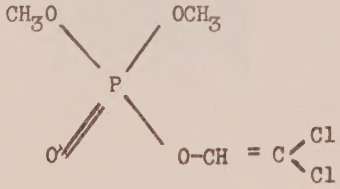
ERRATA SECTION A VOLUME 7

Page 71 - top line substitute 'phenyl' for 'pheynl'

Page 131 - first sentence, 3rd paragraph " 'menace' for 'meance'

Page 175 - 3rd heading and in subsequent paragraph " 'onchocerciasis' for 'onchercerciases'

Page 199 - the structural formula for DDVP is incorrect. The correct form is:



Page 133 - Paragraph headed "Use of Aircraft in Agriculture - Code of Conduct" line 4, substitute 'Contractors' for 'Constructors'.